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Pacific Division
Bendix Aviation Corporation

DLM-17
AFSWP-221

[redacted]
SECURITY INFORMATION

OPERATION AND MAINTENANCE
FOR
Y-10980 TELEMETERING RECEIVING STATION

Bendix Aviation Corporation
Pacific Division
NORTH HOLLYWOOD, CALIF.

DLM-17
AFSWP-221

OPERATION AND MAINTENANCE

FOR

I-10980 TELEMETERING RECEIVING STATION

PACIFIC DIVISION DEVELOPMENT LABORATORIES
Bendix Aviation Corporation
North Hollywood, California

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OPERATION AND MAINTENANCE

FOR

Y-10980 TELEMETERING RECEIVING STATION

INTRODUCTION

Six Bendix Y-10980 telemetering receiving stations have been installed in three USAF mobile trailer, Meteor Motor type K-35, (See Figure 1) and the purpose of this instruction manual is to facilitate the operation and maintenance of these stations and trailers.

The trailers are designated as trailer No. 1, USAF 091088; trailer No. 2, USAF 091100; and trailer No. 3, USAF 091133. Trailer No.'s 1 and 2 are equipped with two complete and independent telemetering receiving stations, each station capable of receiving four separate telemetering channel frequencies. Each station consists of one control cabinet and four receiving cabinets, each of the four containing a crystal-controlled receiver. Trailer No. 3 differs in that it is equipped with one four-channel station, plus one two channel station which is intended to be used as a standby emergency station. This standby station differs from the others in that it consists of only two receiving cabinets. The receivers are tuneable, making it possible to use either of these channels in place of any one of the twenty crystal-controlled channels in the eventuality that a failure occurs. The receiving stations are numbered the same as the trailer in which they are installed with the added designation of "R" or "L" for right or left station.

This manual is divided into two parts: Part I, Y-10980 Telemetering Receiving Station which will deal with the Y-10980 station. Part II, Mobile Telemetering Receiving Trailer will cover the installation external to the Y-10980 stations.

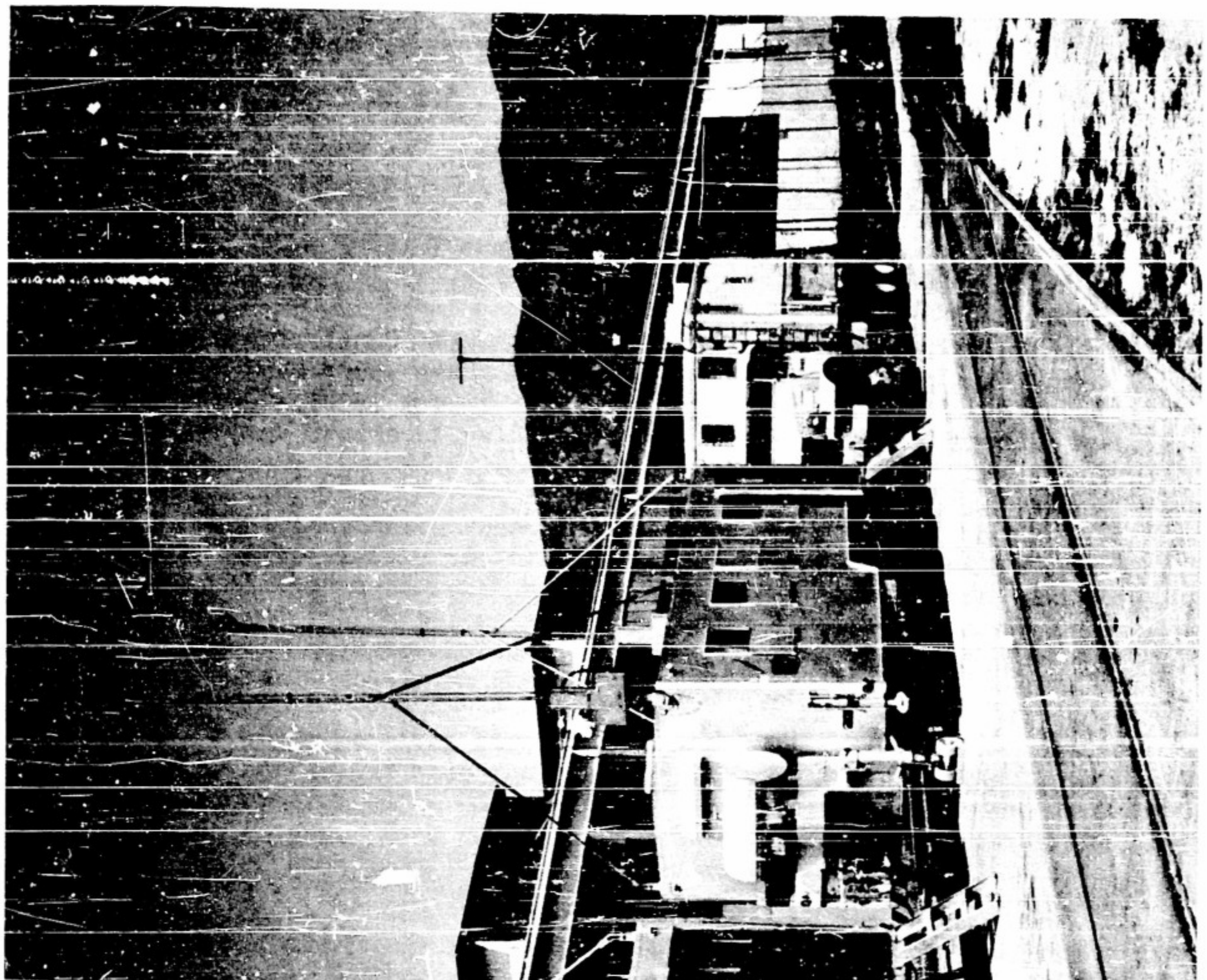


Figure 1 - TRAILER EXTERIOR

PART I

SECTION I

GENERAL DESCRIPTION

1.0 Purpose and Description

Purpose

The Bendix Y10980 Telemetering Receiving Station provides a reliable system for receiving, demodulating and recording telemetered data. The engineering features embodied in this equipment combine to produce an unusually high degree of reliability, accuracy, flexibility and ease of operation.

Bendix telemetering receiving stations are designed to receive frequency modulated radio signals employing continuous or commutated subcarriers, the frequency of each subcarrier being varied in accordance with the quantity being measured (FM/FM telemetering system). A maximum of four radio frequency signals each modulated with three subcarriers can be received and recorded simultaneously on the Y-10980 Receiving Station.

The station receives signals in the frequency range from 235 to 260 megacycles per second which have been frequency modulated by up to three audio subcarriers. After detection, the audio subcarriers are separated by band pass filters. Each subcarrier is then fed to an audio discriminator. The output of each discriminator is an electrical signal whose sense and magnitude is a function of the deviation of the subcarrier from its nominal center frequency.

The output signals are recorded by means of galvanometer oscillographs.

Frequency determining and filter components are supplied for a nominal modulation range of $\pm 7\frac{1}{2}\%$ of center frequency. The subcarrier center frequencies employed in this station are:

Band 1	7.35KC
Band 2	10.5KC
Band 3	14.5KC

Other modulation bandwidths and subcarrier frequencies may be employed by substitution of the proper frequency determining and filter components.

Integral vacuum-tube voltmeter, oscilloscope, and channel selector switches permit visual monitoring of any subcarrier channel. A variable-frequency oscillator and a counter-type frequency meter provide rapid station calibration and subcarrier frequency measurements. Individual channel controls permit independent selection and adjustment of each channel.

1.2 Station Layout - See Figure 2 and 3

The telemetering receiving station consists of four 68 in. cabinets, one 44" cabinet, and two oscillographs. One voltage regulator is supplied for each two receiving stations as these stations were specifically designed to mount two stations to a trailer.

A station assembly is shown in Figure 4. The first three receiver cabinets are identical and provide mountings for the following units in each cabinet:

Regulated Power Supply	1
FM Receiver	1
Subcarrier Amplifier	1
Discriminators	3
Low Pass Filter Chassis	1
Blower Panel	1

The fourth cabinet provides mountings for:

Monitor Panel	1
FM Receiver	1
Subcarrier	1
Discriminators	3
Low Pass Filter Chassis	1
Blower Panel	1

The 44" cabinet provides mountings for:

Frequency Meter	1
Audio Oscillator	1
Oscillograph Control Panel	1
Master Power Panel	1
Small Blowers	2

1.3 Physical Characteristics

Construction: Heavy gage, welded chassis and cabinets. Standard 19 inch width rack mounting panels. All units are supported on slide assemblies and fitted with handles permitting convenient withdrawal for inspection and maintenance. In addition some units can be tilted 90° when withdrawn from the cabinet to further improve the accessibility. Units are locked into position by a hinged bar which folds over the edge of the front panels. Dzus Fastener Locks permit convenient release.

Finish: Black wrinkle finish with chromium trim and permanently engraved lettering.

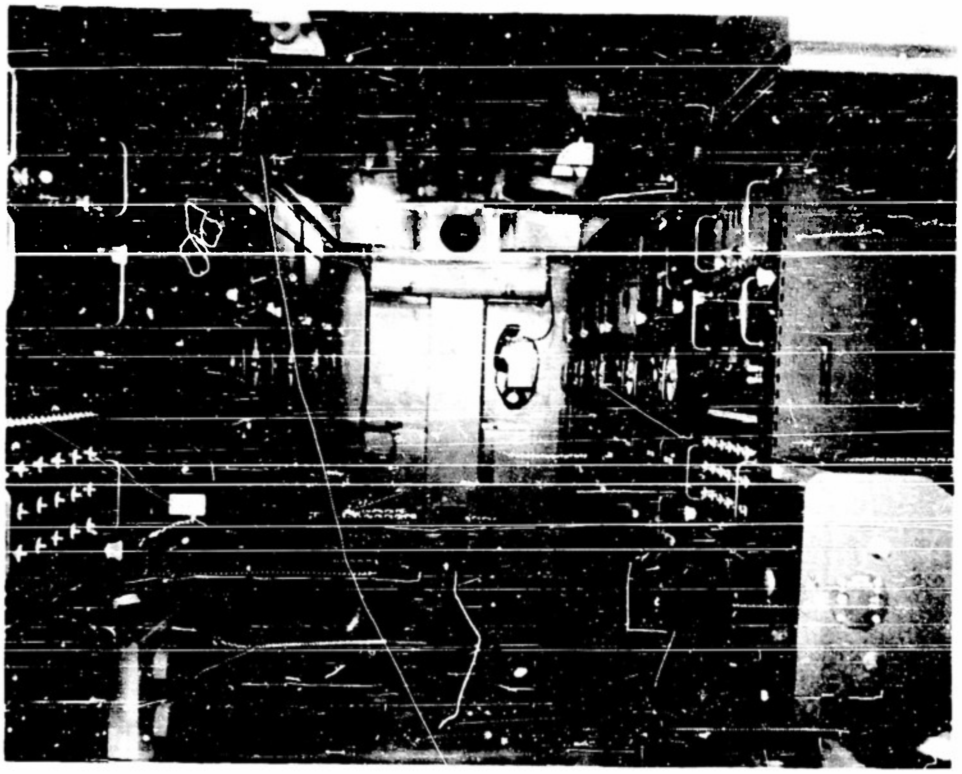


Figure 2 - Trailer Receiving Station Looking Forward

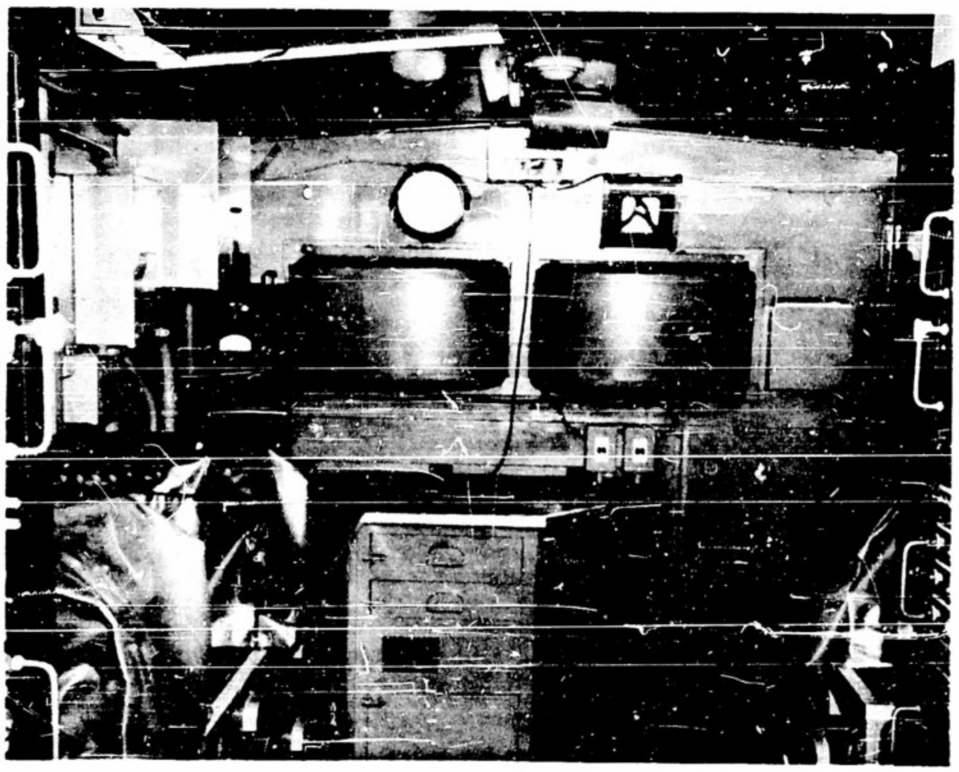
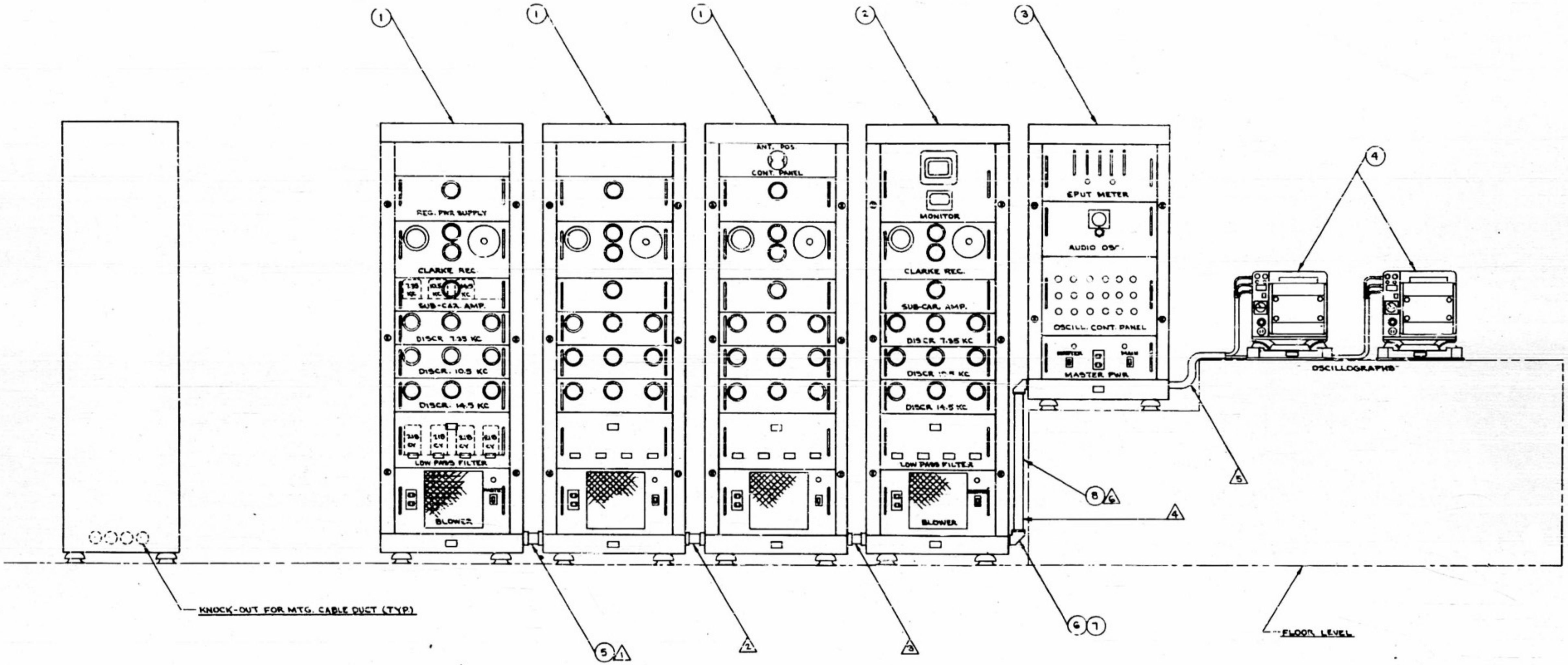


Figure 3 - Trailer Receiving Station Looking Aft



12		36	TYPE 410	RESISTOR, [illegible]
11		2	TYPE 1116-G2	CABLE ASSEM., PWR. RECORDER C.E.C.
10		36	[illegible]	PLUG, GALV. INPUT-CANNON
9		2	RG49-22C-½	PLUG, REMOTE CONTROL INPUT - CANNON
8		1	1½ I.D.	HOSE, RADIATOR [illegible]
7		2	SP 145	L'NUT, GALV. 1½ GEN. ELEC.
6		2	N150	CONNECTOR, BOX-[illegible] GEN. ELEC.
5		3	Y12823	DUCT, CABLE
4		2	TYPE 5-114	OSCILLOGRAPH, RECORDING C.E.C.
3		1	Y10982	CABINET ASSEM., CONTROL (E)
2		1	Y10983	CABINET ASSEM., MONITOR (D)
1		3	Y10984	CABINET ASSEM., REC (A-B)

NOTES:
1. FOR INTER-CABINET WIRING DIAGRAM (A-B) SEE DWG Y12626
2. FOR INTER-CABINET WIRING DIAGRAM (B-C) SEE DWG Y12627
3. FOR INTER-CABINET WIRING DIAGRAM (C-D) SEE DWG Y12628
4. FOR INTER-CABINET WIRING DIAGRAM (D-E) SEE DWG Y12629
5. FOR WIRING DIAGRAM (E-OSCILL.) SEE DWG Y12630
6. CUT TO FIT; PAINT FLAT BLK PER BX. FINISH #17
7. SUPPLIED BY VENDOR WITH OSCILLOGRAPH (ITEM 4)
8. DAMPING RESISTOR FOR GALV. MOUNTED INSIDE PLUG (ITEM 10)

Figure 4 - Receiving Station Assembly, Project 1.3G

Connections: Connections between chassis and cabinet are provided by a multi-conductor plug mounted on the chassis which engages a receptacle mounted at the rear of the cabinet when the chassis slides into operating position. Receptacles are wired to accessible terminal blocks located on the bottom of the cabinet: intercabinet connections are made between these terminal blocks and routed through flexible conduit.

Power Wiring: The main AC line is connected to the Main circuit breaker located on the Master Power Panel in the short cabinet. Branch AC lines extend from the Main control to a separator Master circuit breaker in each cabinet.

Temperature Control: Each cabinet is equipped with a centrifugal blower. Replaceable dust filters are mounted at air inlets.

2.0 Description and Function of Major Units

2.1 FM Receiver See Figure 5

The FM/FM telemetering signals picked up by the antenna are amplified and demodulated by a Clarke, Model 167E receiver. The receiver output is a composite subcarrier signal which is fed to subcarrier amplifier units for separation of the individual subcarrier signals. The output also is fed to a speaker to provide aural monitoring signals. The receiver occupies 8-3/4" of vertical mounting space.

2.2 Subcarrier Amplifier See Figure 6

Each subcarrier amplifier unit provides for separation and amplification of up to four individual audio subcarrier signals. Only the first three channels are used in this station. Installation of the proper plug-in band pass filter is required. Each unit requires 5-1/4 in. of panel space.

2.3 Band Pass Filters See Figure 6

Plug-in Band pass filters mounted in the subcarrier amplifier chassis provide for separation of the individual subcarrier signals from the composite subcarrier signal.

2.4 Regulated Power Supply See Figure 7

The electronically regulated power supply which provides plate power for the filter amplifier units, is conventional in design and is completely contained in one chassis and panel. The Power Supply requires 8-3/4" of panel space.

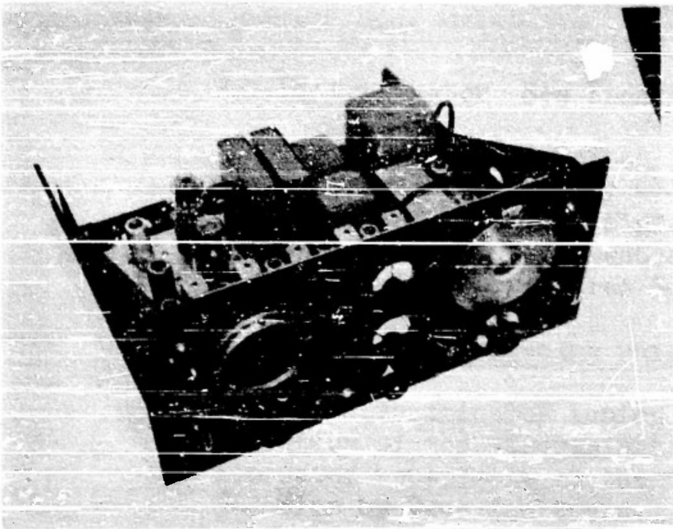


Figure 5 - Clarke 167-E Receiver

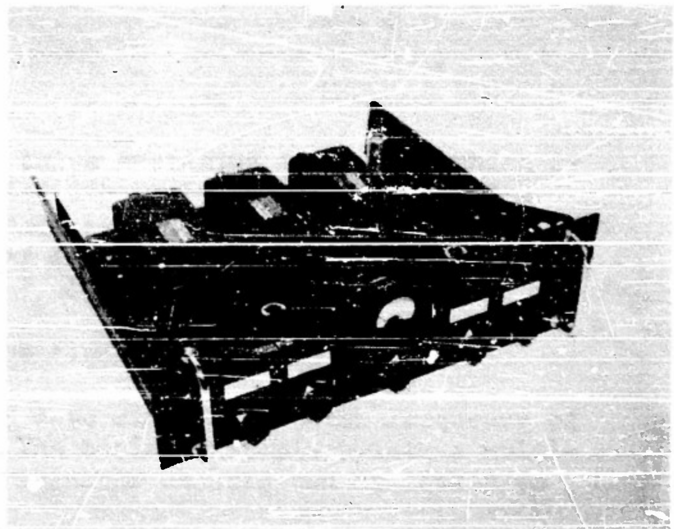


Figure 6 - Subcarrier Amplifier and Band Pass Filter

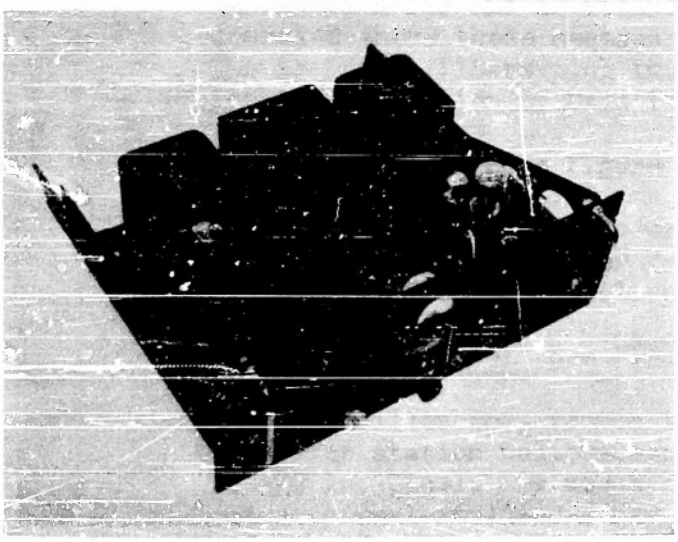


Figure 7 - Regulated Power Supply

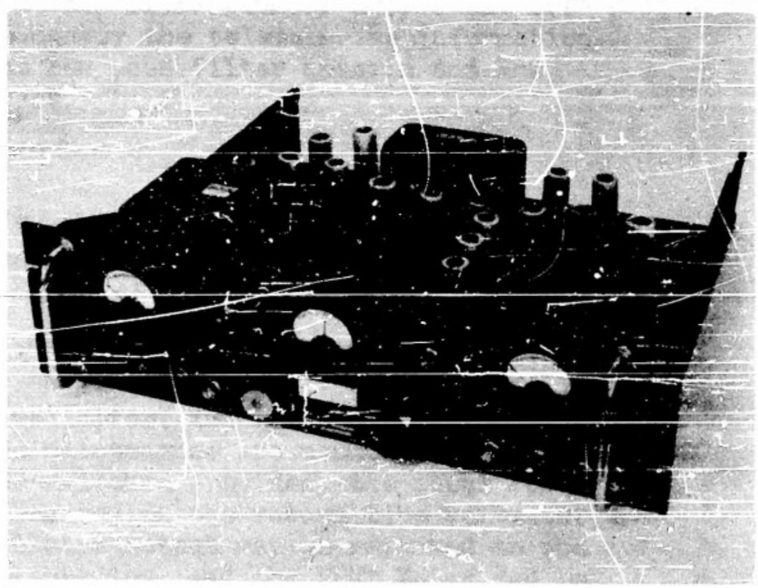


Figure 8 - Pulse Averaging Discriminator and Tuning Unit

2.5 Discriminator See Figure 8

The TDA-4 discriminator is a pulse averaging instrument which is responsive to a frequency modulated subcarrier audio signal. Its output is an electrical signal whose sense and magnitude is a function of the deviation of the subcarrier from its nominal center frequency. The discriminator requires 5-1/4 " of panel space.

2.6 Discriminator Tuning Unit See Figure 8

The discriminator tuning unit determines the center frequency of operation of the discriminator. The tuning unit plugs into a multi-conductor receptacle on the discriminator chassis and is locked in position by Dzus fasteners.

2.7 Low Pass Filter Chassis See Figure 9

Low pass filter chassis provides mounting space for four low pass filters and a means of switching filters in or out. Only the first three channels are used in this station. The L.P. filter chassis requires 10-1/2 in. of panel space.

2.8 Low Pass Filter See Figure 9

The output signal from each discriminator maybe fed to its associated recording galvanometer through a type TFL-2A low pass filter to reduce noise and to attenuate at the discriminator output all frequencies above those necessary to convey the telemetering information. The low pass filters plug into the low pass filter chassis and are locked in position by Dzus fasteners.

2.9 Blower Panel See Figure 10

This unit contains the centrifugal blower with dust filters and the master circuit breaker for each cabinet. The blower panel requires 10-1/2 in. of panel space.

2.10 Monitor Panel See Figure 11

An oscilloscope, vacuum tube voltmeter, and the switching necessary for station calibration, and maintenance are mounted on a 12-1/4 in. panel. By means of the switches provided, the input for output signal amplitudes may be measured on the vacuum tube voltmeter, and viewed on the scope; the oscillator output may be switched to the subcarrier amplifier input for calibration, and the EPUT Meter can be switched to indicate oscillator output or subcarrier output. A switch is also provided to control the recording oscillograph drive motor.

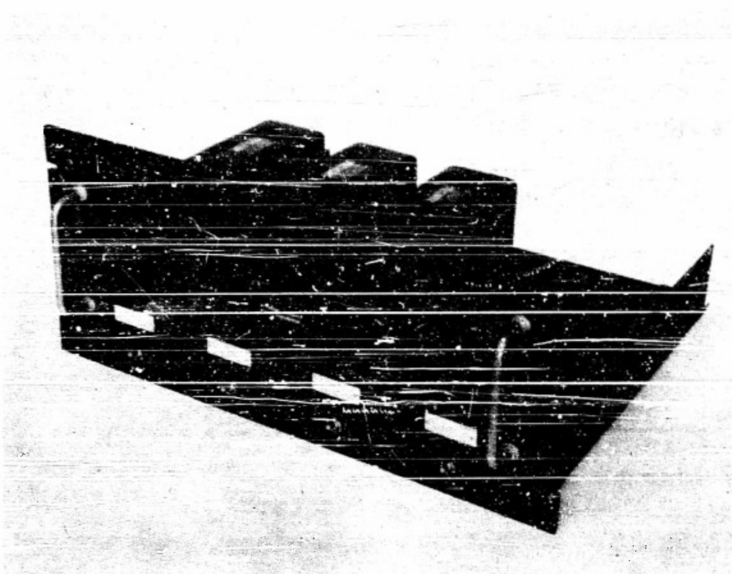


Figure 9 - Low Pass Filter Chassis and Low Pass Filters

Figure 10 - Blower Panel

Figure 11 - Monitor Panel

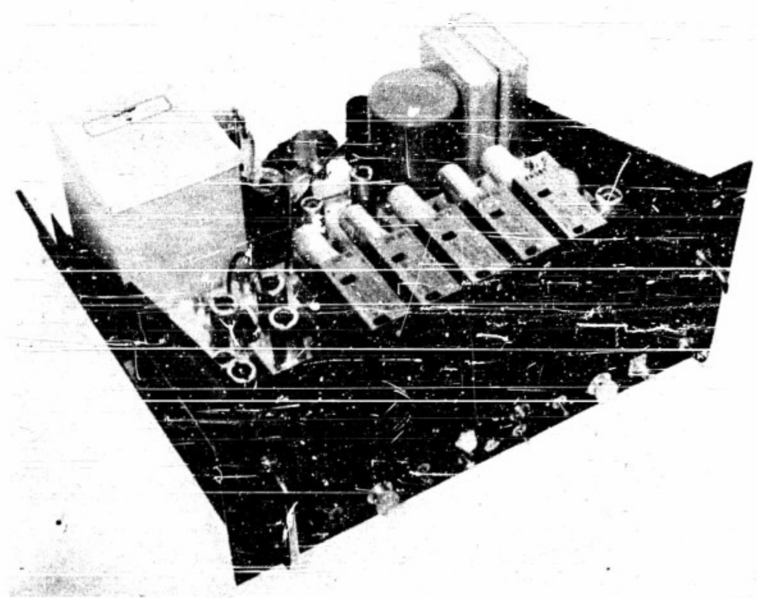


Figure 12 - Berkeley EPUT Meter

2.11 Frequency Meter See Figure 12

A counter-type frequency meter registers the number of sine waves or pulses which occur in an interval of one second. A single count may be displayed continuously or the count may be repeated at approximately two second intervals. The frequency meter requires 8-3/4" of panel space.

2.12 Audio Oscillator See Figure 13

The audio oscillator provides a source of sine wave audio frequency signals for calibration and test of the various subcarrier units in the telemetering receiving station. The audio oscillator requires 8-3/4 in. of panel space.

2.13 Oscillograph Control Panel See Figure 14

The oscillograph control panel provides level control, polarity reversing, signal interruption and patching jacks for a total of eighteen channels. The oscillograph control panel requires 14 in. of panel space.

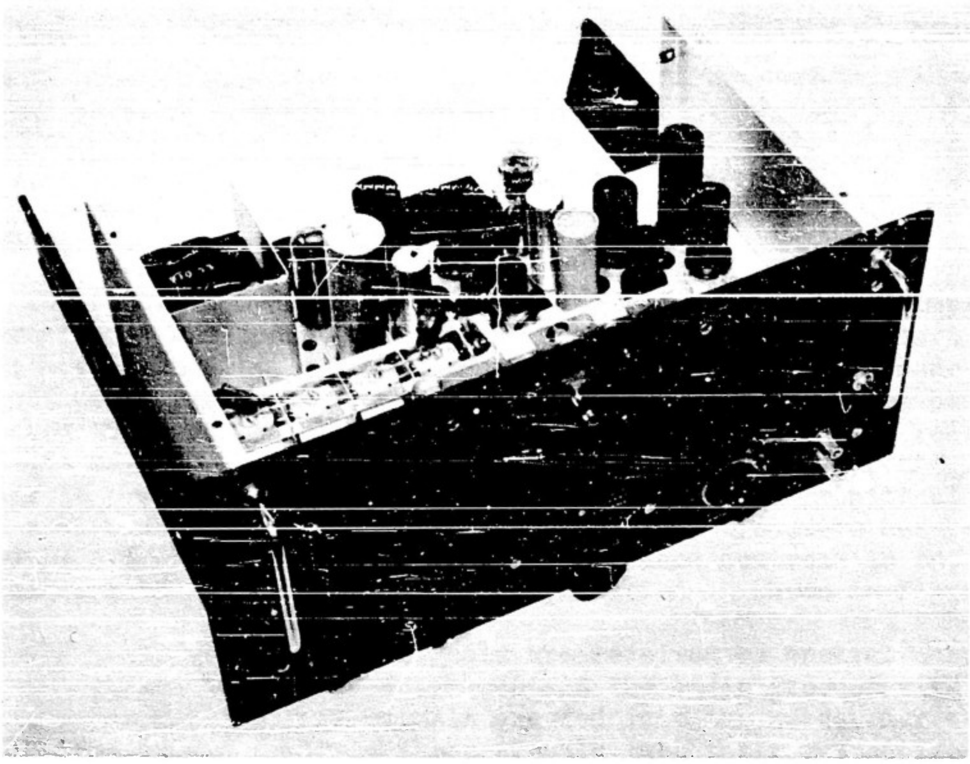


Figure 13 - Audio Oscillator

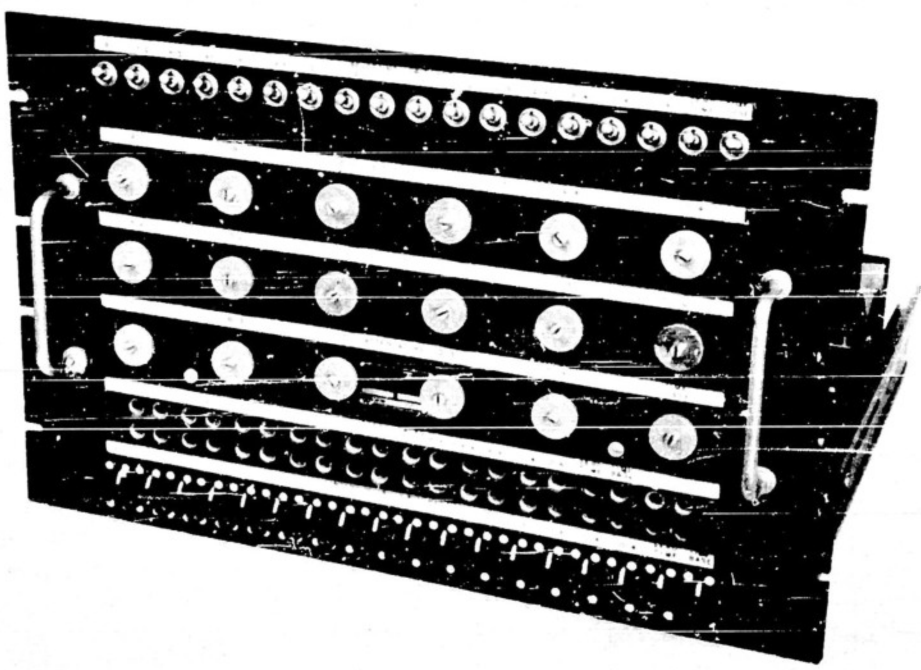


Figure 14 - Oscillograph Control Panel

SECTION II

THEORY OF OPERATION

1.0 General

The Bendix Y10980 FM/FM telemetering receiving station employs conventional and proven circuitry. The design objectives have been accuracy, stability, and ease of operation. Use has been made of recent developments in the telemetry field where evaluation has indicated that use of such developments would enhance system reliability. The discriminator employs the pulse averaging type of circuitry in order to provide increased stability, low drift with or without a signal, and a high degree of linearity. The operating procedure has been simplified by concentrating the most frequently used controls in one area. A block diagram of the Y10980 receiving station is shown in Figure 15.

The radio frequency FM signals are received by special purpose receivers, the outputs of which contain the audio frequency FM signals. These audio frequency FM signals are fed into the subcarrier amplifiers, which amplify and separate these signals into their respective bands. These separated signals are then fed into discriminators, one for each band. The discriminator demodulates the audio frequency FM signal producing an electrical signal whose sense and magnitude is a function of the deviation of the subcarrier from its nominal center frequency, and with proper adjustment of the complete system is a replica of the original signal being telemetered. Provision is made to obtain a permanent record of this signal by connecting the output of the discriminator to a recording galvanometer through a low pass filter, to remove any undesired noise, a reversing switch, for convenience in reversing the deflection of the galvanometer, a "T" pad, to control the level, and a switch, to interrupt the signal. Test equipment has also been included as part of the station for convenience in calibration and maintenance. The following units are supplied: an oscillator to provide a calibration signal, a frequency meter for accurately determining the frequency of the calibration or received signal, and a monitor panel consisting of a VTVM and Scope, associated with the necessary switches to provide a convenient means of calibration and check of the station.

2.0 Model 167-E Clarke Receiver

2.1 General

The special-purpose receiver is designed for a telemetering system employing a radio link and receiving intelligence in the form of frequency-modulated signals. The specified tuning range is from 180 to 260 mc. See Figure 16. Some of the receivers used have been modified for fixed frequency operation, by the addition of a crystal controlled oscillator.

The antenna circuit is arranged for single or unbalanced input.

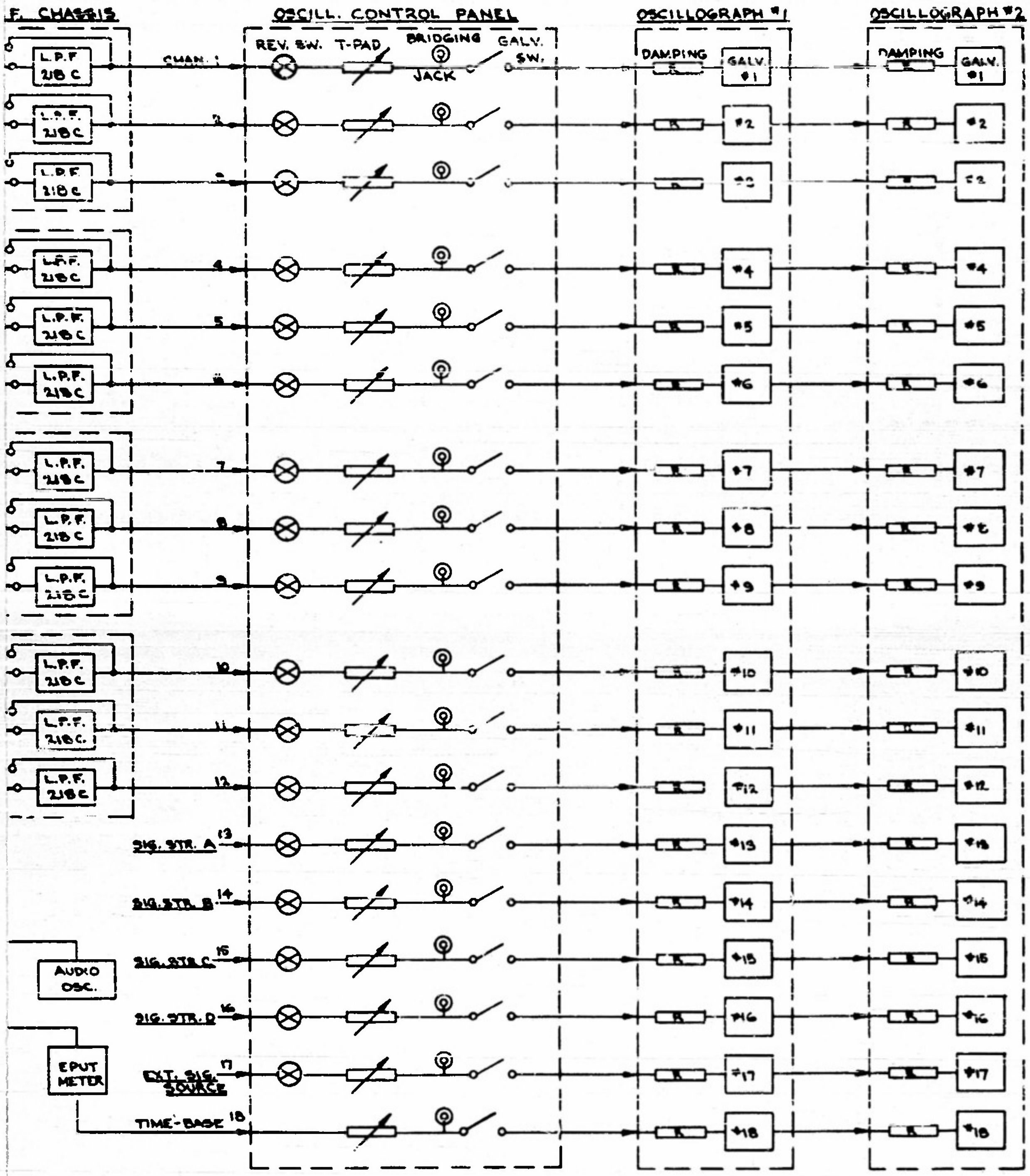
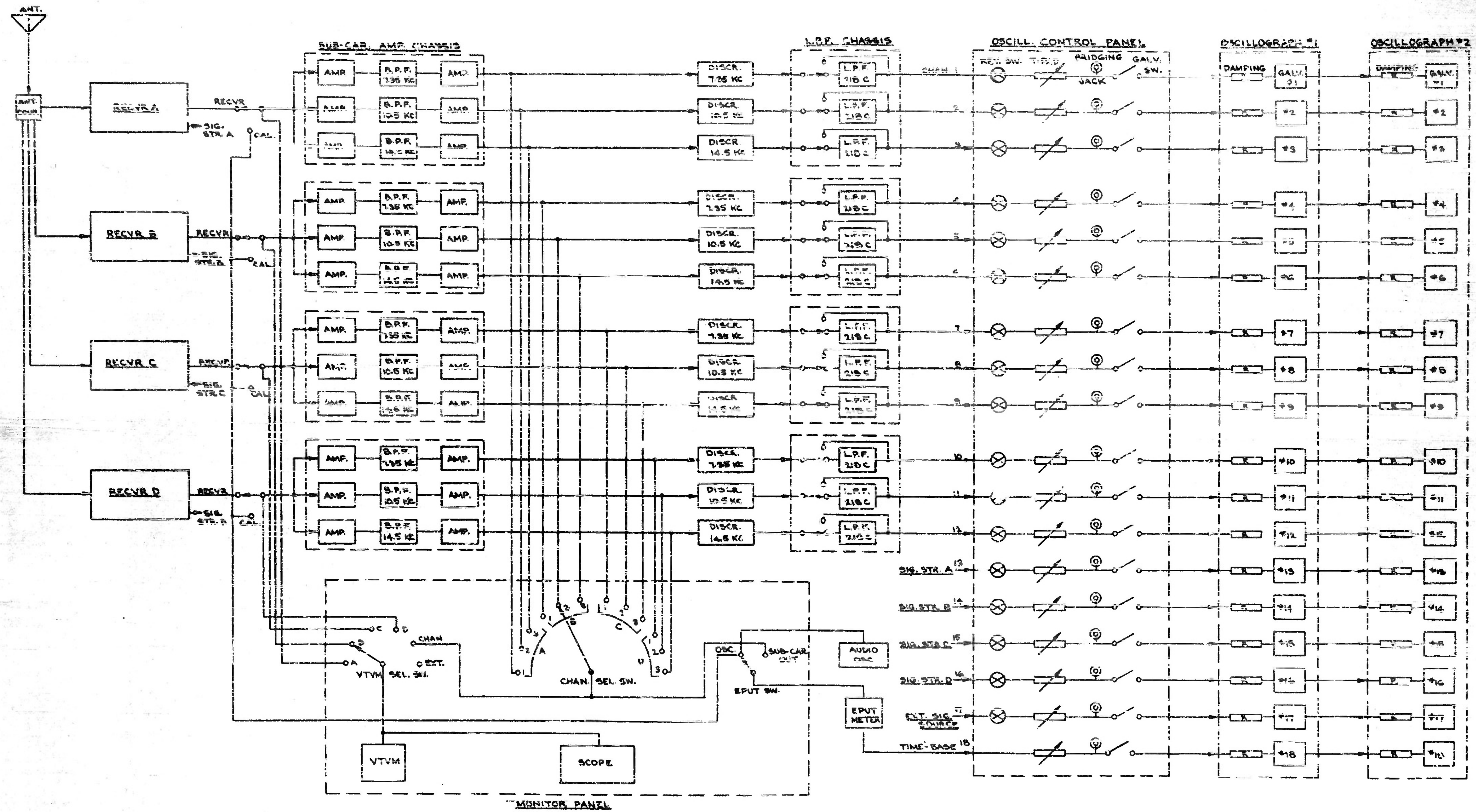
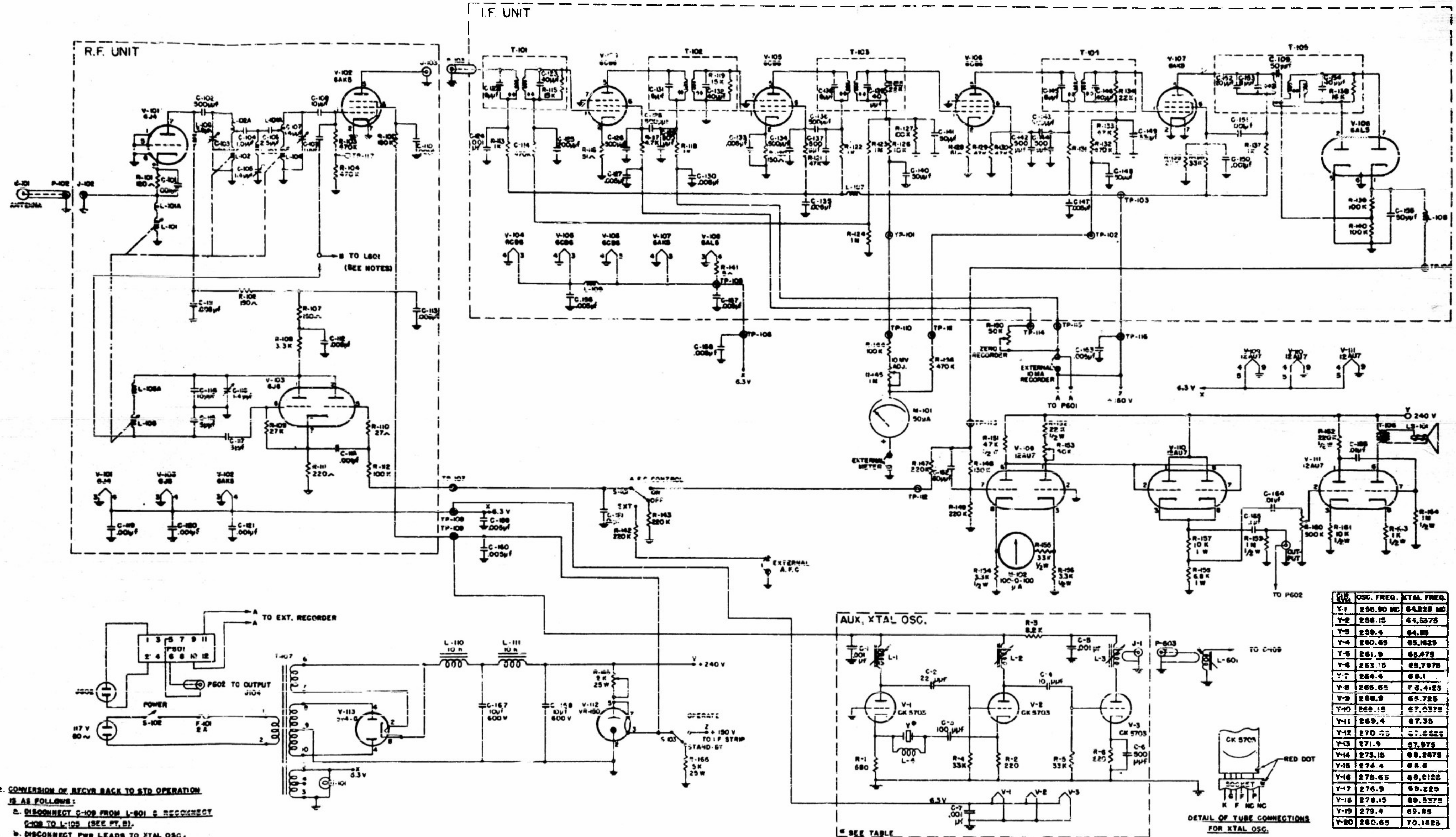


Figure 15 - Block Diagram, Y-10980 Receiving Station
Project 1.3G



NOTE:
1. DIAGRAM SHOWS SIGNAL CIRCUITS ONLY

Figure 15 -- Block Diagram, Y-10980 Receiving Station
Project 1.3G



CIR. SYM.	OSC. FREQ.	XTAL FREQ.
Y-1	256.90 MC	64.225 MC
Y-2	258.15	64.5375
Y-3	259.4	64.85
Y-4	260.65	65.1625
Y-5	261.9	65.475
Y-6	263.15	65.7875
Y-7	264.4	66.1
Y-8	265.65	66.4125
Y-9	266.9	66.725
Y-10	268.15	67.0375
Y-11	269.4	67.35
Y-12	270.65	67.6625
Y-13	271.9	67.975
Y-14	273.15	68.2875
Y-15	274.4	68.6
Y-16	275.65	68.9125
Y-17	276.9	69.225
Y-18	278.15	69.5375
Y-19	279.4	69.85
Y-20	280.65	70.1625

* SEE TABLE

NOTES:

1. SCHEMATIC COVERS MODIFICATION OF STD. CLARKE RECVR BY ADDITION OF AUX. XTAL OSC. & REMOVAL OF 6J6 OSC. TUBE
2. CONVERSION OF RECVR BACK TO STD OPERATION IS AS FOLLOWS:
   a. DISCONNECT C-109 FROM L-601 & RECONNECT C-109 TO L-105 (SEE PT. B).
   b. DISCONNECT PWR LEADS TO XTAL OSC.
   c. INSERT 6J6 OSC TUBE.

Figure 16 - Schematic, Modified Clarke Receiver with Crystal Controlled Oscillator

The basic tuning element around which the front end assembly is designed is a standard Mallory S-4 Spiral Inductuner. A stop assembly is arranged to restrict rotation of the spiral tuner to the last one and one quarter clockwise turn of its normal 5- turn rotation. The signal frequency is tuned by L-101 and the input capacity of the 6J4 plus wiring capacities. A double tuned band-pass circuit is used between the 6J4 r-f amplifier and the 6AK5 mixer to provide high image and i-f rejection. The coupling between the two circuits is capacitive and consists of C104, C105, and C106. C105 is adjustable to provide accurate control of bandwidth. The 6J4 R-F stage is operated at maximum gain at all times to produce maximum signal-to-noise ratio. Bias for the 6AK5 mixer is obtained from the local oscillator. This method produces more uniform operation at all frequencies, allows for considerable variation in local oscillator amplitude due to tube aging, A.F.C. pulling, etc., and allows direct grounding of both cathode terminals to minimize cathode lead inductance and produce maximum input resistance which is necessary at these frequencies. The mixer is pentode connected to prevent distortion of the I-F response due to changes in plate resistance which may be caused by variation of local oscillator amplitude, tube aging, etc. A rather unconventional oscillator configuration is used because of the high frequency of operation and the necessity of A.F.C.

The oscillator circuit used is essentially a Colpitts with an unbypassed resistor connected in the cathode to damp tube resonance. The A.F.C. reactance tube is connected directly across the combination of the grid-plate capacity and a 27 ohm carbon resistor. Input resonance in the reactance tube is not damped by the cathode resistor since the grid circuit must return to the cathode. The use of a small resistor (27 ohms) in the grid circuit extends the operating range through 285 mc. A.F.C. may be turned on or off or supplied from an external source by a front-panel control.

The crystal-controlled oscillator, See Figure 16, which is used when fixed-frequency operation of the Clarke receiver is desired, employs an overtone crystal in a cathode-coupled circuit, and three type CK5703 subminiature tubes.

The crystal frequency was chosen so that adequate oscillator injection could be obtained by doubling twice. A test to determine optimum oscillator injection for maximum sensitivity showed that the optimum value of oscillator voltage was between 4 and 5 volts, and that the injection voltage could vary from 3.0 to 6.0 volts with about a 10% loss in sensitivity.

The link coupling and double-tuned coupling circuit employed permits adjustment of the link so that the optimum value of oscillator voltage may be obtained upon installation in the receiver. A high impedance type of voltmeter is employed to read the rectified grid voltage at TP117. Since TP117 is the midpoint of the mixer grid resistor, whatever voltage is observed must be multiplied by two to obtain the correct injection voltage.

The r-f unit is a complete assembly with input and output signals available through coaxial connectors and with power and A.F.C. leads through a small cable.

The i-f amplifier is a separate, completely shielded assembly which is conventional in most respects. Two high-gain stages using 6CB6 tubes are followed by a 6CB6 first limiter and a 6AK5 second limiter. A 6AL5 is used in a balanced phase discriminator.

The discriminator circuit is a conventional balanced phase shift type. In order to obtain balance the secondary is bifilar-wound and link-coupled to the primary. This link is adjusted in production for minimum distortion. For stability a self-resonant choke is connected to the output lead.

Signal level monitoring is provided by sampling the rectified signal current of both limiter grids. The second limiter developes a voltage proportional to the input signal up to about 10 uv. Above this level the voltage on the second limiter is constant, and a voltage proportional to the logarithm of the input exists at the first limiter. These voltages are combined to produce an easily read logarithmic signal strength scale.

A 12AU7 is used as a DC bridge to indicate discriminator output for tuning purposes and as a direct coupled video amplifier. V110 is used as a cathode follower output stage and is direct coupled from the video amplifier. The output is 10-15 volts RMS for ± 125kc deviation.

A conventional two-stage amplifier with built-in loudspeaker is provided for monitoring.

2.2 External Signal Strength Recording

Provision has been made for supplying 10 ma to record variations in signal strength. This signal is the combined plate and screen currents to V104, and it is adjusted to 10 ma with no signal by varying the screen voltage with R150. The signal thus obtained is reverse reading; i.e., 10 ma is obtained with no signal, and minimum current is obtained at maximum signal. The signal strength circuits are connected to channels 13 to 16 inclusive on the oscillograph control panel.

3.0 Subcarrier Amplifier

The subcarrier amplifier provides for separation of up to four audio subcarrier signals from the composite video subcarrier signal. The four subcarrier amplifier units contained in the telemetering receiving station thus provides sixteen subcarrier amplifier (separation) channels. Each channel consists of a cathode follower input stage, filter, a signal amplifier stage, and a cathode follower output stage. The composite subcarrier signal from the receiver is parallel fed to the subcarrier amplifier channels. See Figure 17.

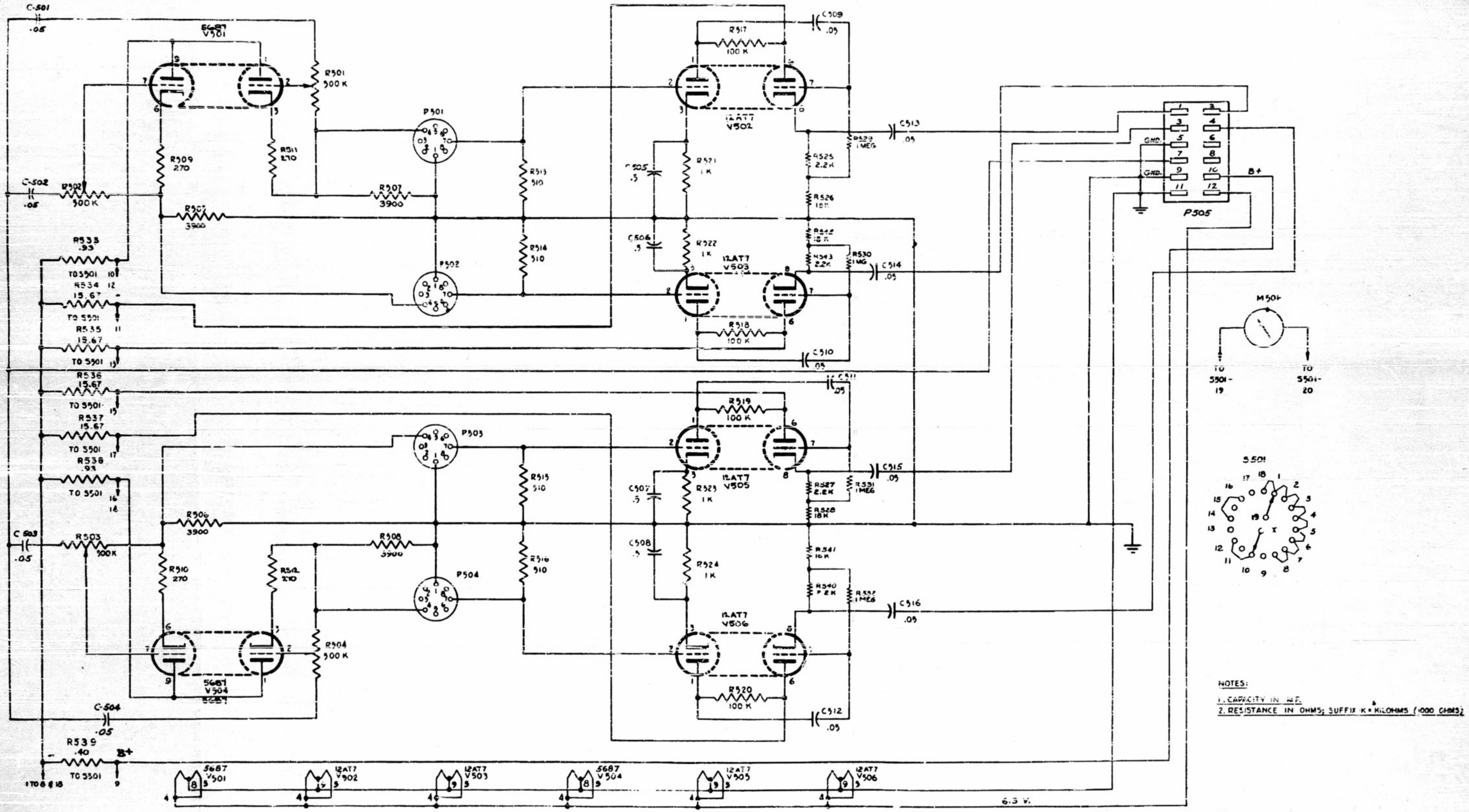


Figure 17 - Schematic, Sub-Carrier Amplifier

The cathode follower input stage of each subcarrier amplifier channel provides high impedance input. Thus the receiver output stage is lightly loaded even though it drives the fourstages in parallel. The cathode follower input stages also provide the proper driving impedances for the filters.

Twelve of the channels are equipped with plug-in band pass filters. The filters normally provided with the station have center frequencies. as noted in Section I. Filters are available on special order with center frequencies ranging from 0.4 to 70.0 kilocycles per second, and with bandwidths to provide for deviation of $\pm 7\frac{1}{2}$ or ± 15 percent of center frequency. Each filter passes the subcarrier channel for which it was designed while rejecting all others. Representative performance of the filters is shown in Figure 18. Attenuation from the band edge of each filter to the cross over point with the adjacent pass band is not less than 45 db.

4.0 Discriminator

4.1 General

The TDA-4 discriminator is a pulse averaging instrument which is responsive to a frequency modulated subcarrier audio signal. Its output is an electrical signal whose sense and magnitude are a function of the deviation of subcarrier from its nominal center frequency. Each discriminator is tuned to one of the subcarrier channels by an interchangeable plug-in tuning unit. The schematic of the discriminator is shown in Figure 19.

4.2 Characteristics

4.2.1 Input Range: Full limiting with 0.3 to 50 volts rms input. Nominal range 2.0 to 8.0 volts rms.

4.2.2 Center Frequency Range: 400 cps to 70 kc, center frequency determined by plug-in tuning unit employed.

4.2.3 Input Impedance: 500 K ohms.

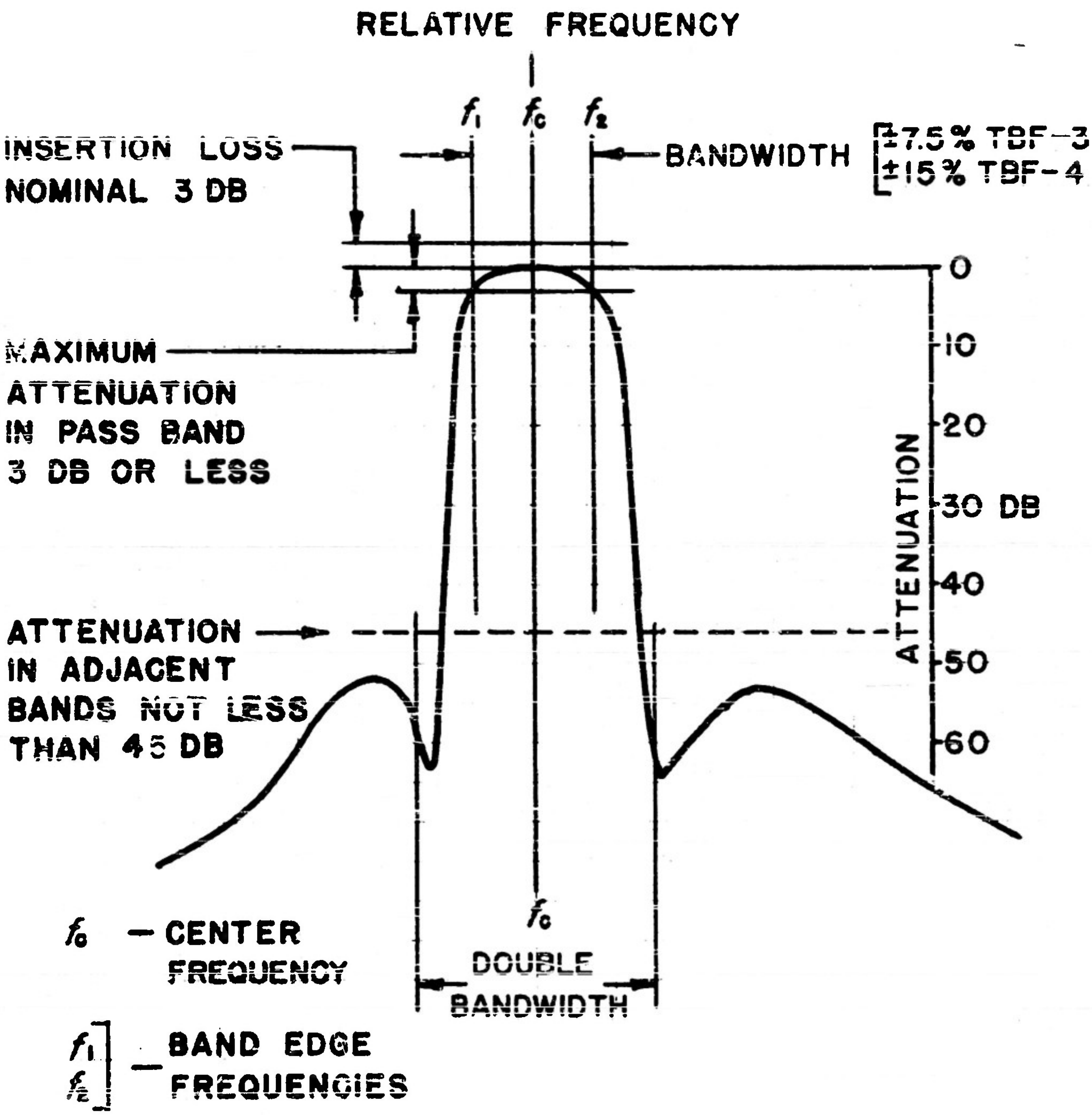
4.2.4 Subcarrier Frequency Deviation: Determined by tuning unit employed. Tuning units providing for $\pm 7\ 1/2\%$ or $\pm 15\%$ of center frequency are normally employed.

4.2.5 Intelligence Frequency: Modulation may be dc to as much as 50% of bandwidth, determined by tuning unit employed.

4.2.6 Output Level: Minimum of ± 10 milliamperes corresponding to $\pm$ full subcarrier deviation from center frequency.

4.2.7 Output Impedance: 330 ohms nominal.

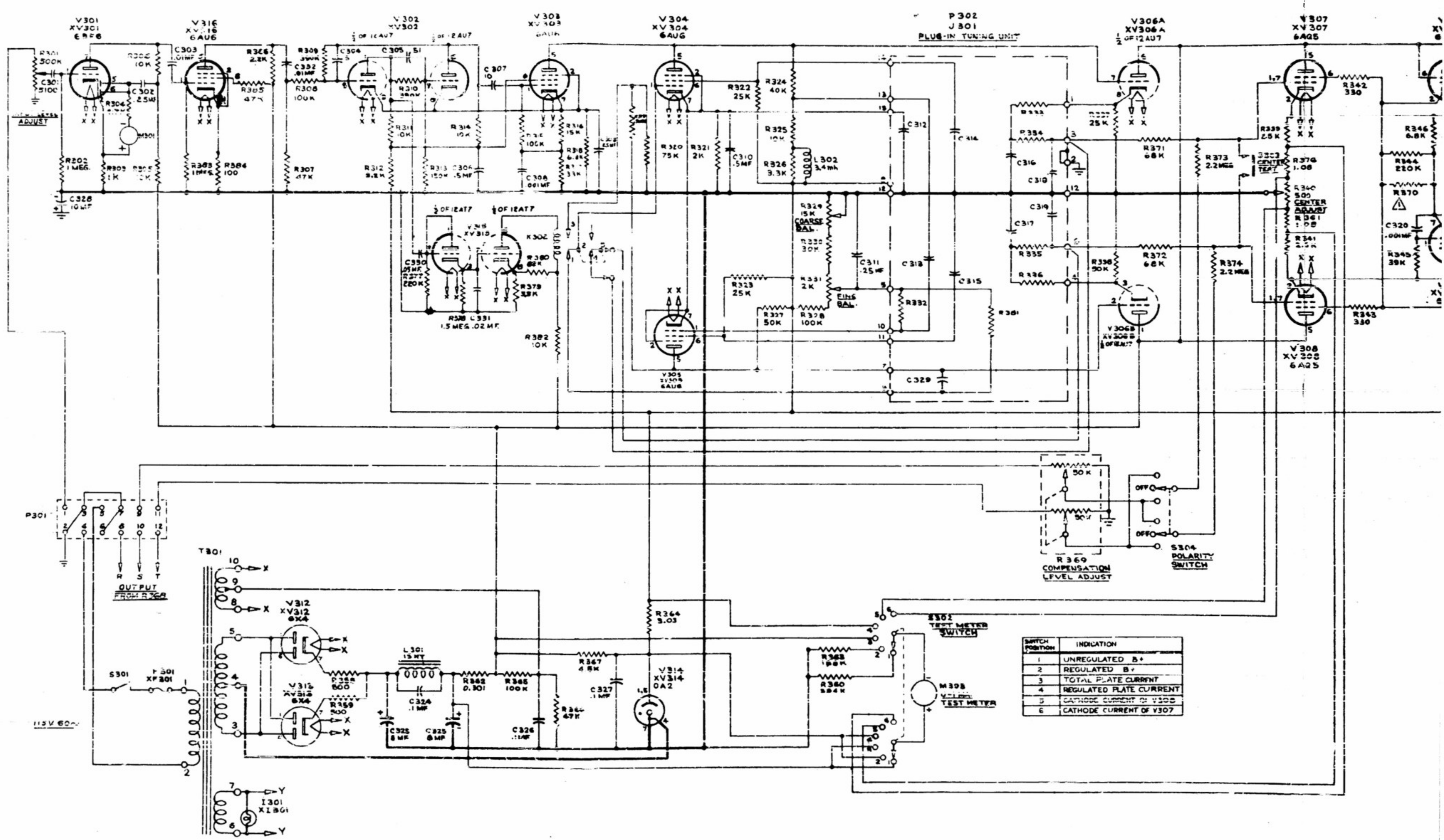
4.2.8 Type of Output: Push-pull cathode followers, balanced to chassis ground.



TYPICAL RESPONSE OF BAND PASS FILTER

MODELS TBF-3 & TBF-4

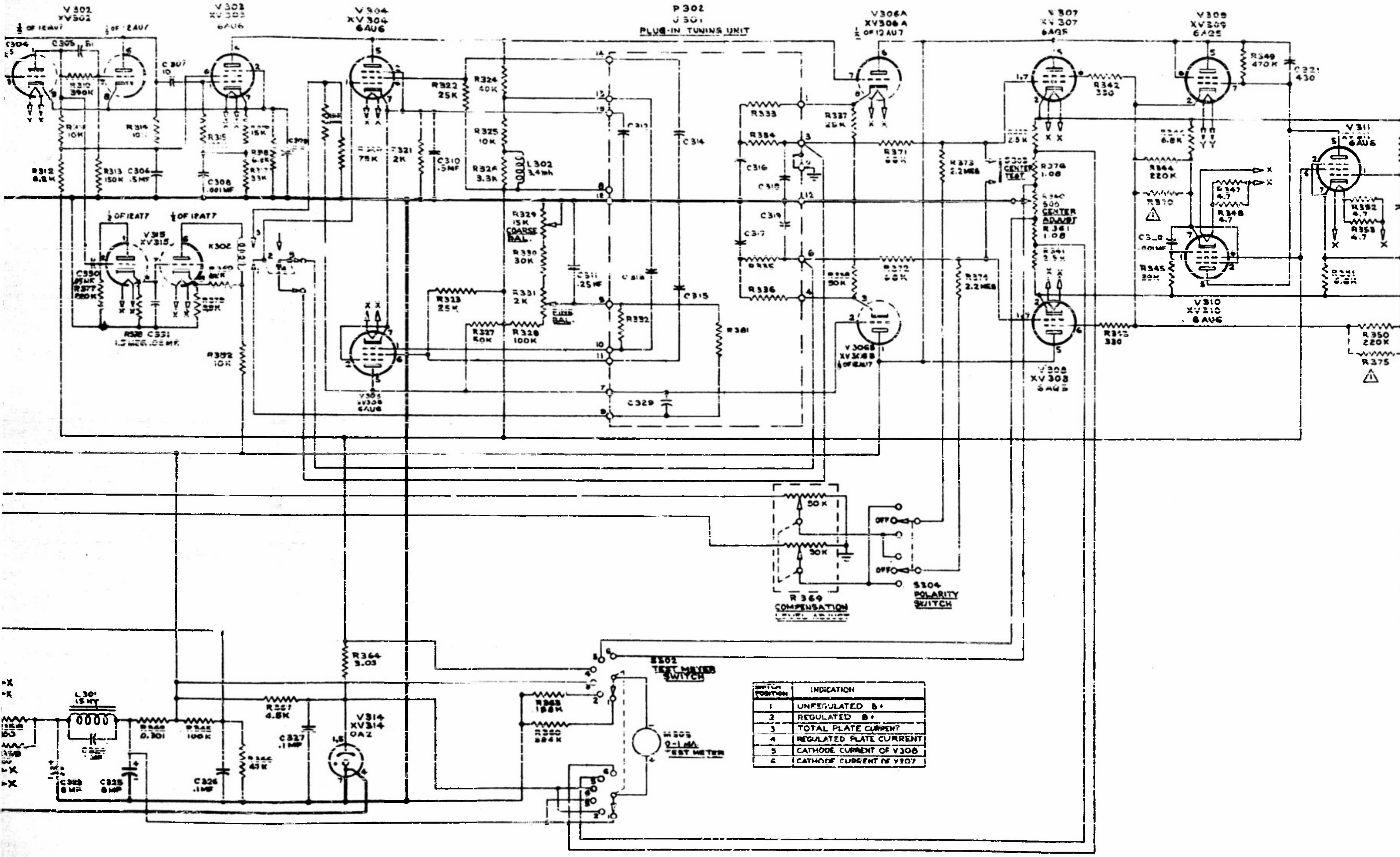
Figure - 18



V301 XV301 6BF6
V316 XV316 6AU6
V302 XV302 ½ OF 12AU7
V303 XV303
V304 XV304 6AU6
V305 XV305 6AU6
V306A XV306A ½ OF 12AU7
V306B XV306B ½ OF 12AU7
V307 XV307 6AQ5
V308 XV308 6AQ5
V312 XV312 6X4
V313 XV313 6X4
V314 XV314 OA2
V315 XV315 ½ OF 12AT7
P302 J301 PLUG-IN TUNING UNIT
S304 POLARITY SWITCH
R369 COMPENSATION LEVEL ADJUST
S302 TEST METER SWITCH
M301 TEST METER
CENTER ADJUST
COARSE BAL.
FINE BAL.
OUTPUT FROM RCVR
P301
T301
I301 XI301
S301
F301 XF301
115 V 60~
SWITCH POSITION | INDICATION
1 UNREGULATED B+
2 REGULATED B+
3 TOTAL PLATE CURRENT
4 REGULATED PLATE CURRENT
5 CATHODE CURRENT OF V306
6 CATHODE CURRENT OF V307

1

Figu



SWITCH POSITION	INDICATION
1	UNREGULATED B+
2	REGULATED B+
3	TOTAL PLATE CURRENT
4	REGULATED PLATE CURRENT
5	CATHODE CURRENT OF V308
6	CATHODE CURRENT OF V307

CENTER FREQ.	C312	C313	C314 AND C315	C316 AND C317	C318 AND C319	R332	R333 AND R336	R334 AND R335	R381	C329
400 CPS	10 MF	.002 MF	0.5 MF	.05 MF	[illegible]	1 MEG	68K	680K	1.5MEG	[illegible]
560 CPS	10 MF	.0015 MF	0.5 MF	.05 MF	.005 MF	1 MEG	68K	560K	1.5MEG	240 MMF
780 CPS	10 MF	.001 MF	0.5 MF	.03 MF	.005 MF	1 MEG	68K	470K	1.5MEG	[illegible]
960 CPS	10 MF	800 MMF	0.5 MF	.02 MF	.005 MF	1 MEG	68K	390K	1.5MEG	160 MMF
1.5 KC	10 MF	600 MMF	0.25 MF	.02 MF	.002 MF	1 MEG	68K	560K	1.5MEG	[illegible]
1.7 KC	1.0 MF	450 MMF	0.25 MF	.016 MF	.002 MF	1 MEG	68K	470K	1.5MEG	100 MMF
2.3 KC	0.5 MF	360 MMF	0.25 MF	.01 MF	.001 MF	1 MEG	68K	680K	1.5MEG	[illegible]
3.0 KC	0.5 MF	250 MMF	0.1 MF	.008 MF	[illegible]	1 MEG	68K	470K	1.5MEG	47 MMF
3.9 KC	0.5 MF	200 MMF	0.1 MF	.0068 MF	430 MMF	1 MEG	68K	680K	1.5MEG	[illegible]
5.4 KC	—	150 MMF	0.1 MF	.0051 MF	430 MMF	1 MEG	68K	560K	1.5MEG	27 MMF
7.35 KC	—	100 MMF	0.1 MF	.003 MF	430 MMF	1 MEG	68K	390K	1.0MEG	25 MMF
10.5 KC	—	75 MMF	.05 MF	.002 MF	100 MMF	1 MEG	68K	680K	820K	22 MMF
14.5 KC	—	51 MMF	.05 MF	430 MMF	[illegible]	1 MEG	68K	470K	820K	[illegible]
22.0 KC	—	[illegible]	.05 MF	330 MMF	50 MMF	1.2 MEG	75K	680K	560K	[illegible]
30.0 KC	—	25 MMF	.05 MF	620 MMF	33 MMF	1.0 MEG	82K	[illegible]	560K	12 MMF

NOTE:
△ TO BE DETERMINED DURING TEST AND CALIBRATION.
ALL RESISTORS ARE IN OHMS; K=1000 OHMS.
2. ALL CAPACITORS ARE IN MMF EXCEPT AS SHOWN.

2

Figure 19 - Schematic, Discriminator Pulse Averaging

4.2.9 Linearity of Output vs Subcarrier Frequency: 0.5% of bandwidth.

4.2.10 Output Response vs Intelligence Frequency: Flat within ±1 db.

4.2.11 Output Stability: ±0.5% of bandwidth per hour for two hours, after 15 minute warmup period.

4.2.12 Maximum Output Noise Level: Less than 5 millivolts.

4.2.13 Power Source: 115 volts regulated, 60 cps, 100 v.a. Regulation within ±1% is required for specified performance. Nominal output variation is ±0.2% of bandwidth per volt line variation.

4.2.14 Panel Size: 5-1/4 inch x 15 inch.

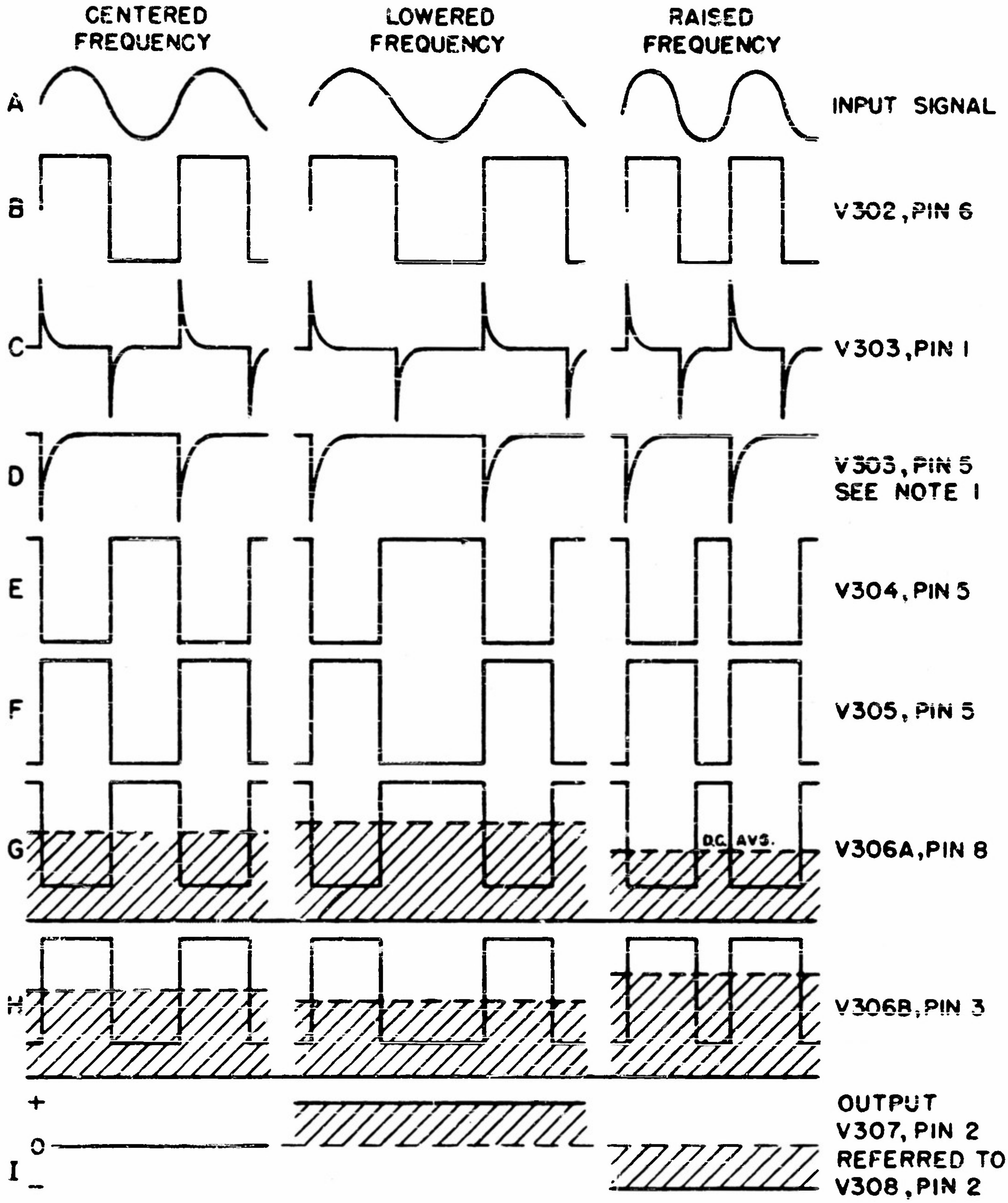
4.2.15 Chassis Size: 13 inch x 17 inch x 2 inch.

4.2.16 Weight: 28 pounds.

4.3 Circuit Theory:

Tube, V301, is a linear preamplifier with an input level control, R301, appearing on the front panel. This tube includes a diode which rectifies part of the signal voltage to operate the signal level meter, M301. V316 is a clipper-driver stage using a 6AU6 which clips the input sine wave. Tube V302 is a 12AU7 twin triode and is used in an Eccles Jordan trigger circuit having two stable limiting conditions. The amplified frequency modulated subcarrier signal, shown as waveform A in Figure 20 is clipped by V316, then triggers the E.J. circuit on each half cycle, and produces a rectangular output from the trigger circuit, wave B. This signal is differentiated by means of the 10 uuf capacitor, C307, and the 100K ohm resistor, R315, to produce waveform C. The signal is applied to the grid of V303, which is normally in a plate current cutoff condition. The cathode return of V302 is common with V303 through resistor R318. The voltage drop across this resistor due to the plate current through V302 holds V303 at cutoff. V303 conducts only on the positive half cycles of waveform C, clipping the negative half cycles. Its pulse output is shown as waveform D. The pulse repetition rate is the same as the subcarrier frequency.

This pulse is applied to a univibrator including tubes V304, and V305, having one stable limiting condition, and one unstable condition. In the stable condition V305 is conducting and V304 is conducting and V304, is cut off. The negative pulse of waveform D is applied to the grid of V305 through resistor R324 and capacitor C313. This cuts off V305 which causes V304 to conduct. This is the unstable limiting condition and continues for an interval determined by the time constant of C313 and R332 and the threshold voltage on the grid of V305. This voltage is adjustable and is controlled by the balance controls R329 and R331. These are available on the instrument panel. At the end of the unstable



NOTE: 1. UNIVIBRATOR WAVEFORM IS SUPERIMPOSED. REMOVE V304 TO OBSERVE WAVEFORM ILLUSTRATED.

TDA-4 DISCRIMINATOR WAVEFORMS

Figure - 20

period V305 returns to the conducting condition which causes V304 to again go to cut off. This sequence of operations is repeated for every cycle of the subcarrier frequency.

The pulse form at the plate of V304 is shown in waveform E and that at the plate of V305 in waveform F. These two pulses are applied to the grids of two cathode followers V306A and V306B, a 12AU7 twin triode. As shown in waveform E, when the grid of the upper triode A moves negatively with the first half cycle of the subcarrier signal, the grid of the lower triode B moves in a positive direction, F. Waveforms E and F also represent the pulse forms present at the cathode of the two triodes. The average DC voltage at the grid or cathode is represented by the dashed lines in E and F. This line is located when the shaded area under the curve of the negative pulse is equal to the shaded area under the positive pulse. Elongation of the positive in E will thus move the DC average line upward as in G. This represents a lowering of the subcarrier frequency. Increasing the frequency will shorten the positive pulse and lower the average DC voltage at the cathode of triode A as in I.

Similarly in waveform H elongation of the negative pulse caused by lowered frequency will lower the average DC positive potential at the cathode of triode B, and increase frequency will raise it, as in J. These voltages are measured from the negative return or copper ground, and not from the chassis.

The DC average at the grid of triode V306A shown at E, is somewhat positive with respect to the DC average at the grid of triode B shown at F. This is the voltage condition at center frequency. As an example, the average positive potential on the grid of upper triode A is approximately +87 volts and that on the lower triode is +82 volts at center frequency. Since center frequency is represented by equal voltages at the cathodes of these triodes, cathode resistor R337, used with triode A is smaller than resistor R338, used with lower triode B. Thus due to the different cathode currents in the two triodes the average DC voltage drops across these resistors are approximately equal at center frequency.

Increase of subcarrier frequency will thus produce a cathode voltage unbalance, with the cathode of triode A negative with respect to cathode B. A frequency lower than center frequency reverses this unbalance, with the lower cathode negative with respect to the upper cathode.

An average DC voltage difference between the two cathodes is thus brought about by a change in frequency. These two DC voltages are applied to the grid of V307 and V308 through RC filters in the plug-in tuning unit which serve to filter the pulses from the DC voltages. These tubes are used in a voltage measuring bridge circuit, and the 100-0-100 output meter, M302, is connected between their cathodes.

This is a zero center meter and when there is no voltage difference between the cathodes of V307 and V308, the meter indicates zero (center scale). Zero meter reading indicates center frequency. Lower frequency moves the meter pointer to the left of zero. Frequencies higher than center frequency will move the pointer to the right.

A protective thermal delay relay, K301, and the 330 ohm output T-pad, R368, are connected in series with the meter M302. The relay delays closing the circuit through the meter and output circuit until all tubes have reached a stable operating condition. This is to protect the meter and the galvanometer connected to the output circuit from current surges during the tube warmup period.

A center adjust control, R340, and test switch, S303, are provided on the front panel for adjusting the voltage balance at the cathodes of V307 and V308. For balancing, switch S303 is closed, connecting the girds of V307 and V308 together. The center adjust control is then adjusted until the output meter M302 and the recording galvanometer read zero. The test switch S303 is then opened. When the incoming subcarrier is known to be on center frequency, the balance controls R329 and R331 are adjusted to bring the meter and galvanometer again to zero readings. The meters will now accurately indicate frequency deviations above or below center frequency.

With a discriminating circuit of this type, circuit failure or off band operation of the input signal might damage the indicating meters. Therefore, protective circuits are provided. If the pulse amplifier tube, V303, fails, the univibrator remains in its stable limiting condition. Tube, V304, would be cut off and the grid cathode of V306A would be highly positive. Tube V305 would be conducting and the grid and cathode of V306B would remain negative with respect to the grid and cathode of V306A. A serious and continued unbalance at the cathodes of V307 and V308 would result. Much higher than normal current would flow through the indicating and recording meters with resultant damage to the meters. To prevent this damage if this unbalance should occur, tubes V309, V310, and V311 will operate to protect the meters as follows: The screen current for tubes V307 and V308 passes through V309 from the plate supply. Since the grid of V309 is connected to the positive plate supply through R349, the plate resistance of this tube will normally be low. The plates of tubes V310 and V311 also connect to the grid of V309. The cathodes of these tubes return to the cathodes of V307 and V308 and their grids connect to the opposite cathodes. Thus the cathode of V311 connects to the cathode of V308 through R351, and its grid to the opposite cathode V307. V310 is connected symetrically opposite with its grid to V308 and cathode to V307.

Tubes V310 and V311 are normally held at cutoff by means of DC bleeder current through R350 and R351 for one tube, and through R344 and R346 for the other tube. Tubes V310 and V311 therefore measure the DC unbalance which may occur between the cathodes of V307 and V308. If that unbalance exceeds the threshold bias voltage on either tube, it draws plate current through R349. This places negative bias on V309, reducing its plate current and also the screen current to tubes V307 and V308. Cathode voltages at these tubes are thereby reduced thus limiting the current through the meters to a safe value. If the subcarrier shifts too far out of the band on the low frequency side, V311 operates to protect the meters. If on the high frequency side, then V310 comes into operation.

The leads to the low pass filter are connected to terminals 8 and 10 on connector P301. Full output signal, unaffected by the setting of this output T-pad, may be obtained between terminals 10 and 12.

4.4 Standby Stabilization Circuit:

During normal operation of the station the equipment may stand for extended periods without being in actual use, although the power is on. Under these conditions, the hysteresis of electron emission of tubes V304 and V305 may cause some difficulty in maintaining balance. In the "no signal" condition tube V305 is in a conducting condition and tube V304 is cutoff. When later the circuit is balanced while receiving an incoming signal, it may be found that the balance will drift with time due to the hysteresis of V304 and V305 and also to some extent, V306, V307 and V308. This of course necessitates rebalance.

To minimize this difficulty a standby stabilization circuit is provided using tube V315 and relay K302. The relay is shown in its non-operated position, with no incoming subcarrier present. With the arrival of a subcarrier signal, rectified voltage is applied to the grid of V315, causing this tube to conduct, and to operate the relay. The relay closes contacts 2 and 3, connecting the plate of V305 to the grid of V304 through the voltage divider of R319 and R320. Contacts 4 and 5 of the relay are opened, removing the short circuit between the grids of V307 and V308. This prepares the circuit for normal operation as previously described.

During periods of no incoming signal, there will be no rectified signal voltage on the grid of V315. The relay K302 will thus be non-operated, and with circuit connections as shown. Contacts 1 and 2 will thus be closed, making a circuit from the grid of V304 back through capacitor C329, to the plate of V305. A positive feedback loop is thus established from the plate of V304 through R324, C313, V305, C329, contacts 1 and 2 of relay K302, to the grid of V304. This circuit thus oscillates at a frequency determined by these circuit constants and also the DC voltage at the grid of V305. This voltage, as previously mentioned, is controlled by the settings of the balance controls R329 and R331. When these controls are previously balanced for center subcarrier frequencies, this circuit will oscillate at approximately center frequency. Thus when the incoming signal fails, and also during standby periods, tubes V304 and V305 will continue to function, and draw the same plate currents, as when normal signal reception is occurring. The cathode emission characteristics of these tubes will thus not be changed due to extended periods of quiescent standby operation.

Contacts 4 and 5 of relay K302 are wired to terminals 3 and 6 of jack 308. Therefore in the standby condition, the grids of V307 and V308 are connected together, and these tubes will thus draw approximately equal plate currents. Average cathode emission requirements of these tubes will also be the same, with or without subcarrier signal. Similarly the triodes of V306 operate at approximately equal plate currents with or without subcarrier signal, because tubes V304 and V305 are always in an operative condition. Center frequency balance is thus stabilized over long periods of standby operation, through elimination of cathode emission hysteresis. In the event of signal failure the indicating meters return to zero or center frequency.

4.5 Power Supply Circuit

A conventional power supply is provided on the chassis to supply all heater and plate voltages for the discriminator circuits. Two 6 X 4 rectifiers V312 and V313 are used to conduct the approximate 130 milliamperes required. Tubes V301, V306, V307, V308, V309, V310 and V311 receive 300 plate volts unregulated. Supply voltage to all other tubes is 150 volts regulated. V314 is the regulator tube. This is an OA2, 150 volt regulator, and the socket is so wired that the negative return to the power transformer is opened when the tube is removed from it.

A test meter and test switch are provided on the front panel for checking plate supply voltages and currents. The switch is a six-position switch and is wired to measure the following:

Position 1 - Unregulated plate voltage
2 - Regulated plate voltage
3 - Total plate current
4 - Regulated plate current
5 - Plate current-tube V308
6 - Plate current-tube V307

Optimum operation of the equipment occurs with meter readings within the marked green range, but entirely satisfactory operation can be expected with meter readings between .7 and .9.

4.6 Discriminator Compensation Circuit.

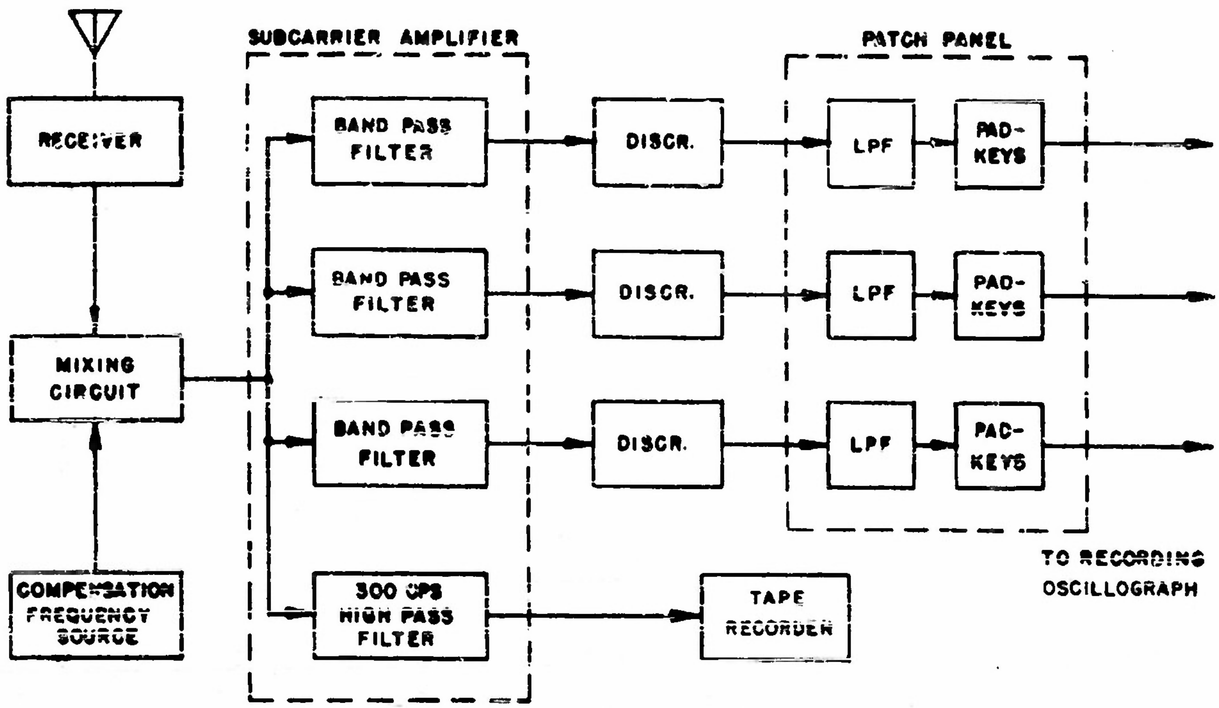
A compensation input connection is provided in the discriminator. This may be used in making permanent oscillograph records from composite subcarrier signals which have been previously recorded on tape. External controls and connections for this circuit appear on the rear chassis wall adjacent to the power connector. In making a tape recording of a composite telemetering signal, the recording mechanism sometimes introduces a frequency instability or wow. To minimize this effect when the recording is played back, and when the permanent separation record is made on the recording oscillographs, frequency compensation may be provided. The circuits which may be used are shown in Figure 21.

Circuit A shows a method of tape recording a composite telemetering signal. This method includes recording along with the composite video signal, a signal from the audio oscillator of selected frequency. The frequency used must be one which is not present in the composite video, but one for which a band pass filter is available. The signal from the receiver and audio oscillator must be mixed in a linear mixing circuit (not supplied) and fed to the 300 cycle high pass filter, and then to the recorder as shown. Other filters and discriminators may be used simultaneously if desired. The amplitude of the oscillator signal must be comparable to that of the composite signal. The frequency of the oscillator must be accurately adjusted to the center frequency of one subcarrier channel.

When at a later time, it is desired to obtain oscillograms from the composite tape recording, circuit B is used. As shown, the output from the tape recorder is connected to the filter/amplifier input jack in the receiver cabinet. Band pass filter/amplifiers and discriminators are connected for all subcarrier frequencies in the composite video signal. One additional band pass filter/amplifier (2) is used, with center frequency equal to that of the audio oscillator used during the original recording. The signal from this filter feeds and additional discriminator. Signals from terminals 8 and 10 (connector P301) of this discriminator are amplified in a DC amplifier (not supplied) and connected as shown to terminals 9 and 11 of P301 of all discriminators in use. Referring to the discriminator schematic, terminals 9 and 11 of connector P301 bring the signal from the DC amplifier to the compensation level adjusted R369. From there the DC voltage is applied through resistors R373 and R374 to the grids of the discriminator output tubes V307 and V308.

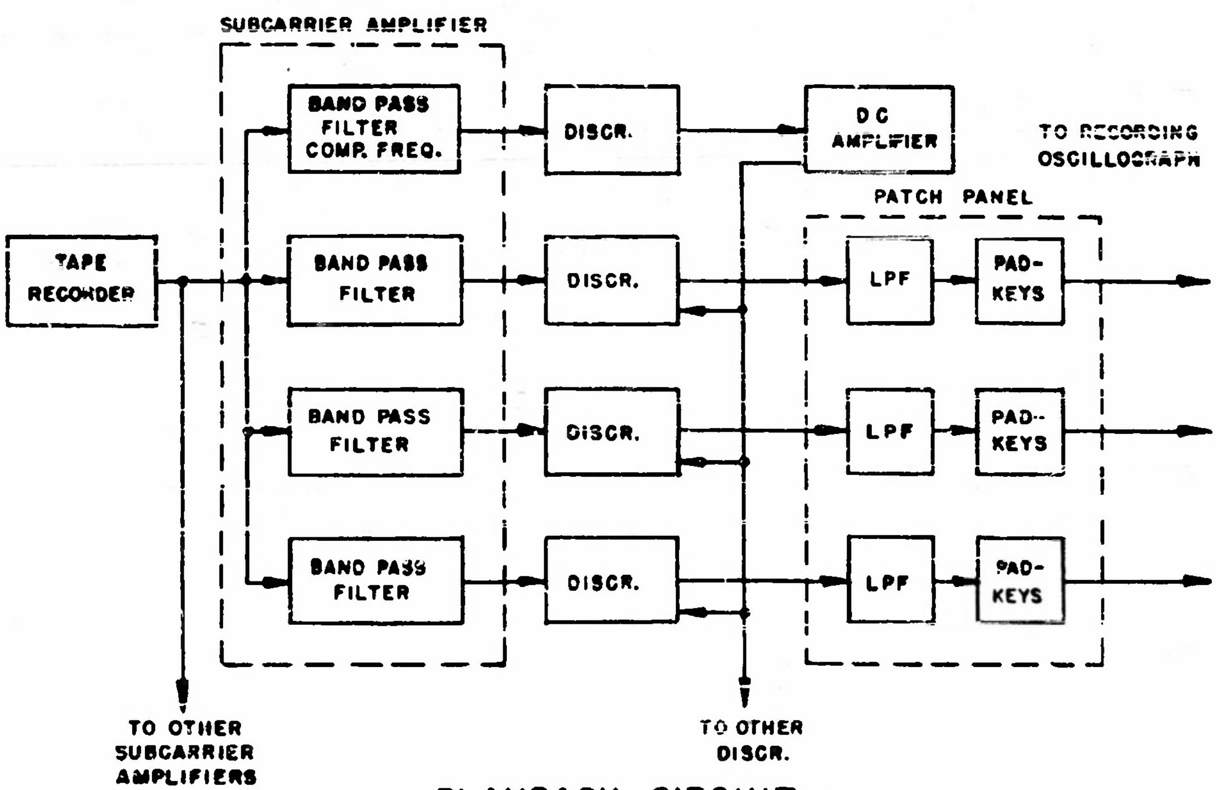
In operation, the signal from the audio oscillator is recorded on the tape together with the composite video signal. During the recording, any irregularity in tape velocity will cause frequency instability in the recorded signals. Again during playback additional frequency instability may be introduced. This effect may be minimized by proper use of the circuits shown.

In circuit B the DC output voltage from discriminator (1) will be a function of the recorded signal of the audio oscillator in circuit A. If during playback the frequency of this signal varies, the DC output voltage from the discriminator will vary. Similarly the frequencies of all subcarrier signals to all discriminators will vary and will cause a corresponding variation in all discriminator output voltages. The amplified output voltage from discriminator (1) is



AN OSCILLOGRAPHIC RECORDING MAY BE MADE
SIMULTANEOUSLY WITH THE COMPOSITE TAPE RECORDING

RECORDING CIRCUIT



PLAYBACK CIRCUIT

Figure - 21

SUGGESTED RECORDING COMPENSATION CIRCUITS I16316 applied to all other discriminator compensation circuits. When this voltage is of the correct polarity and amplitude, it will counteract the instability of output voltages from these discriminators, which is due to the recording instability. A polarity reversing switch S304, mounted on the front panel of the unit permits selection of the proper compensation polarity, and R369 permits adjustment of proper amplitude.

External phasing circuits may be required if the compensation signal frequency differs greatly from the subcarrier frequency, or frequencies in the composite signal. Since the amount and phasing of the distortion will depend on the recording equipment employed, it is suggested that initial adjustments be made with simulated signals. Incorrect wiring or adjustment could result in loss of an irreplaceable recording.

5.0 Oscillograph Control Panel See Figure 22

For ease of calibration and checkout all output signals are brought to the oscillograph control panel. Each channel has a reversing switch, a 330 ohm "T" pad, a signal interrupting key switch and, an output bridging jack.

The twelve discriminator outputs are connected to channels 1 to 12 inclusive, the receiver signal strength outputs to channels 13 to 16 inclusive. Channel 17 is used for timing signals and channel 18 is used for the 1 cps time base signal.

6.0 Oscillograph

The oscillographs are Consolidated Type 5-114 which are equipped to record 18 channels of information. Two oscillographs are used with each station. The galvanometers in one unit are in series with those in the other unit, to insure two identical records. Refer to CEC Instrument Manual.

7.0 Test and Calibration Equipment

7.1 Audio Oscillator See Figure 23

Accurately measured audio frequency calibration signals for the subcarrier amplifiers and discriminators are obtained from a Hewlett-Packard Audio Oscillator. Switches on the monitor panel connect the oscillator to any of the subcarrier amplifiers.

7.2 Frequency Meter See Figure 24 and 25

The frequency meter is a Berkeley Scientific Co. Model 554 Events-Per-Unit-Time-Meter which consists of five decade scaling units, a one second time base derived by division from a 100 kilocycle crystal standard, appropriate gating circuits, and a regulated power supply. Signals of unknown frequency, of sine wave or other recurring wave form are shaped by input amplifiers and are then fed to a gating circuit which is controlled from the one second time base. The count, equal to

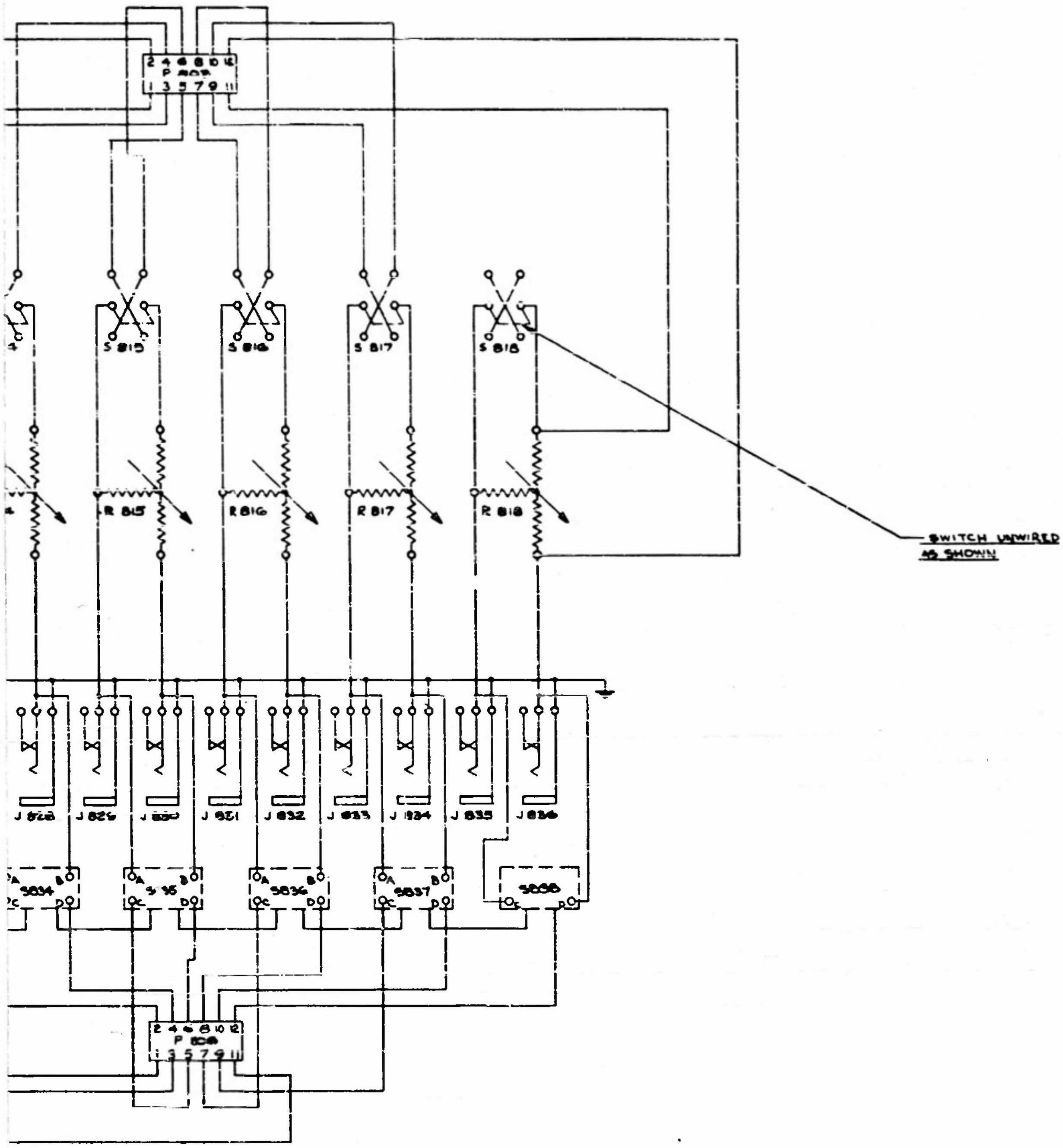


Figure 22 - Schematic, Oscillograph Control Panel

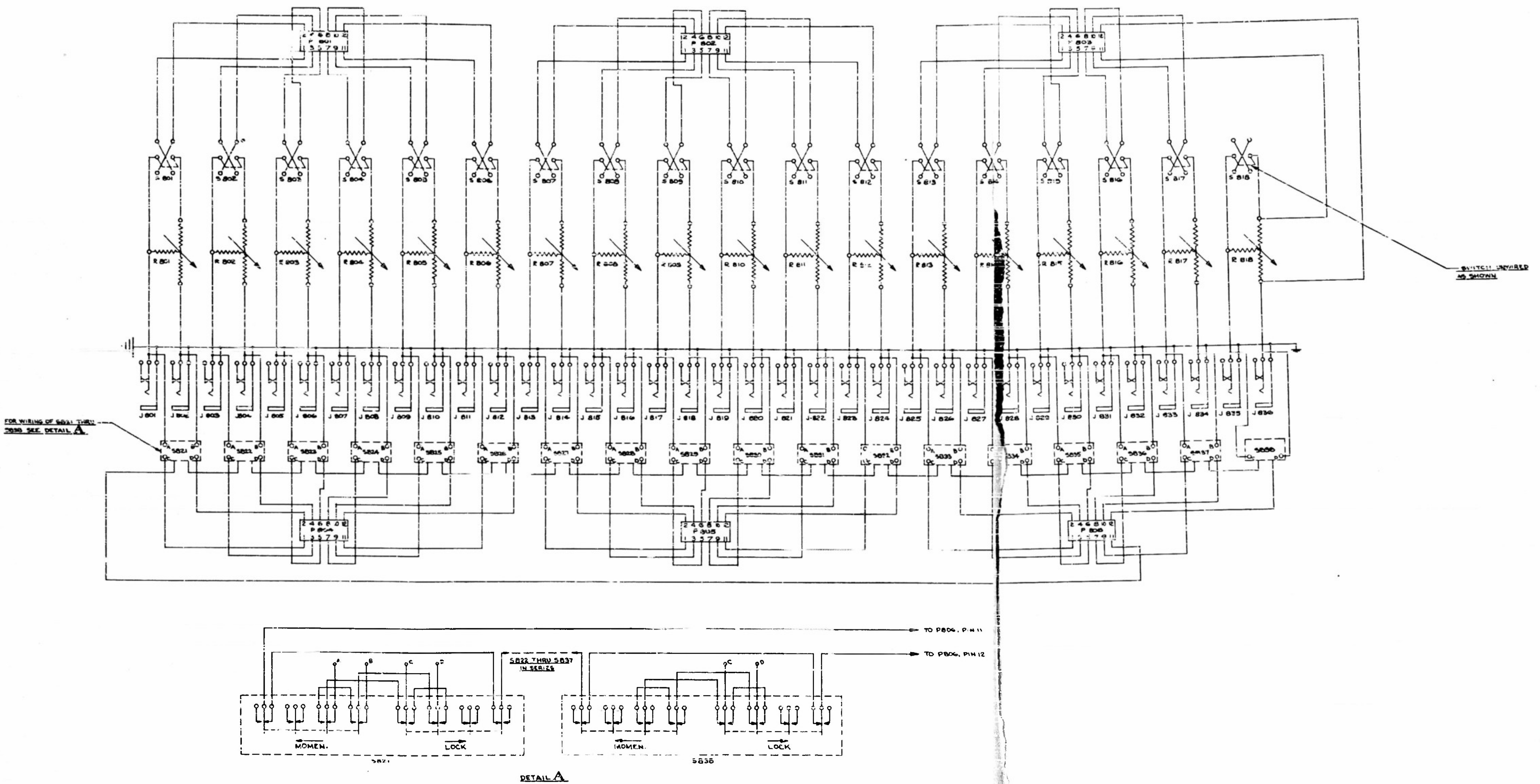


Figure 22 - Schematic, Oscillograph Control Panel

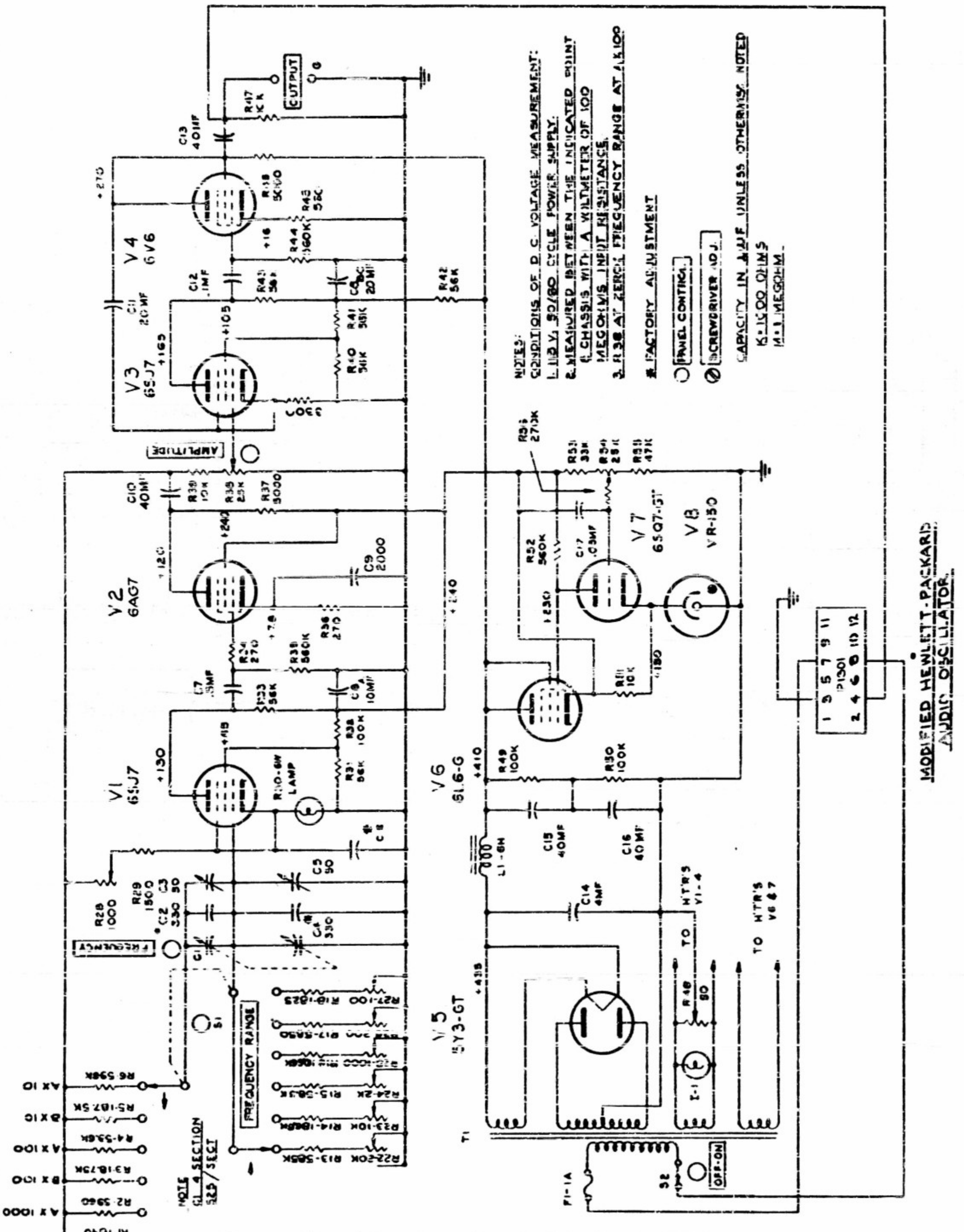


Figure 23 - Schematic, Modified Audio Oscillator

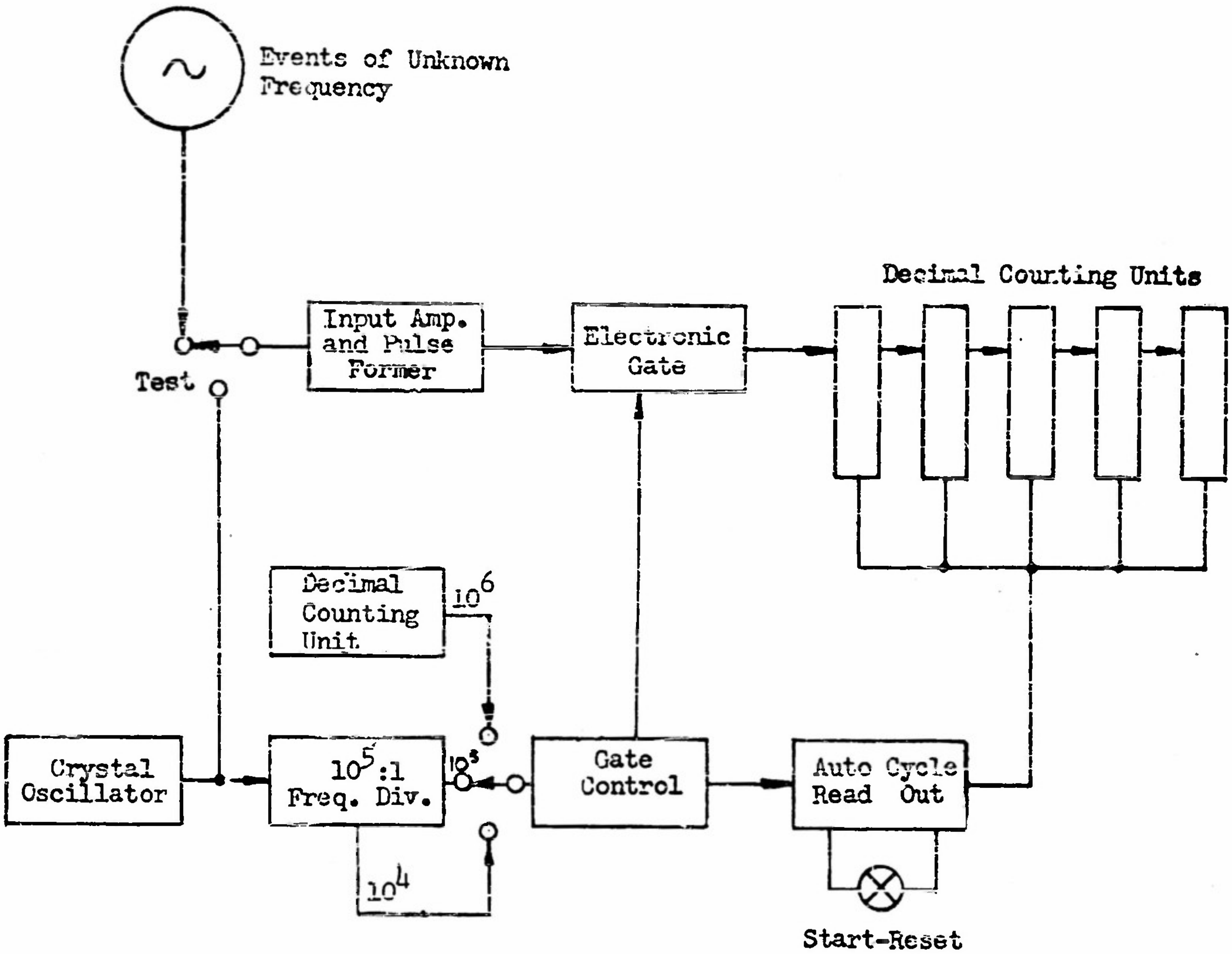
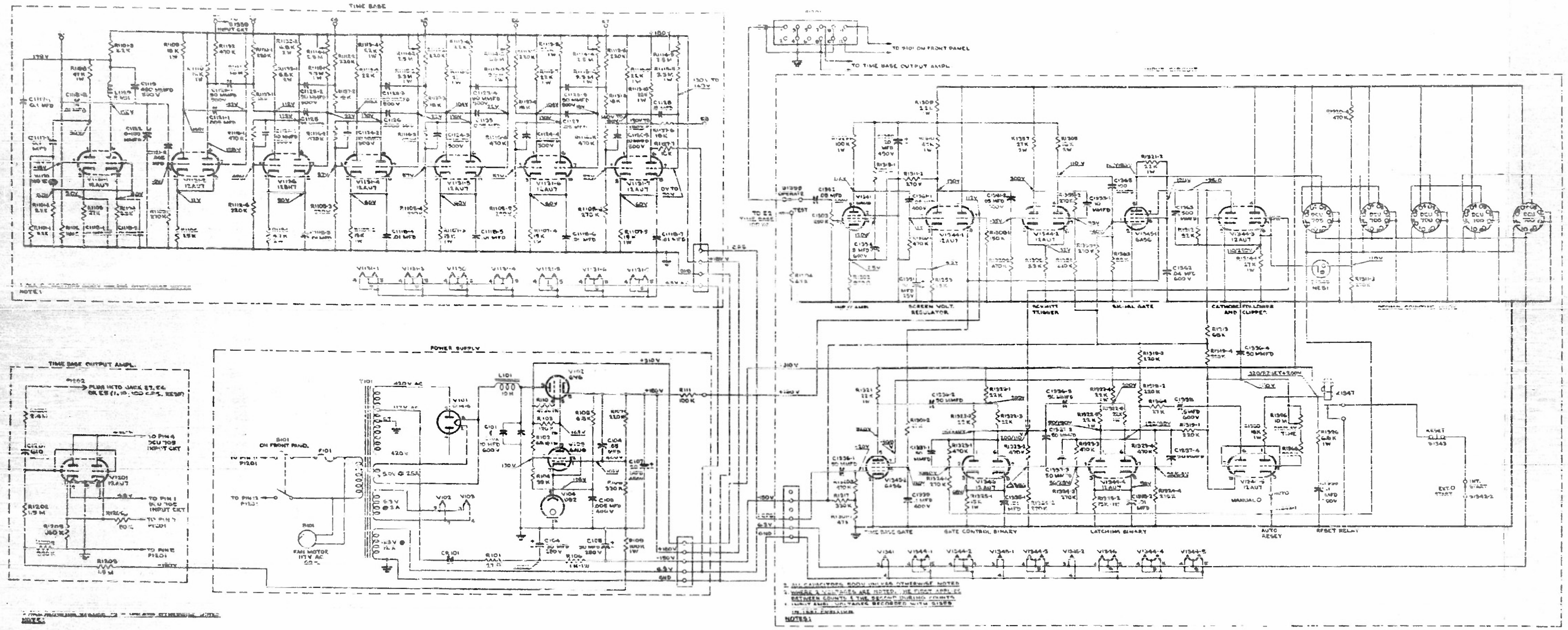


Figure - 24 BLOCK DIAGRAM EPUT METER

I 17336


TIME BASE
POWER SUPPLY
TIME BASE OUTPUT AMPL.
INPUT CIRCUIT
SCREEN VOLT. REGULATOR
SCHMITT TRIGGER
SIGNAL GATE
CATHODE FOLLOWER AND CLIPPER
TIME BASE GATE
GATE CONTROL BINARY
LATCHING BINARY
RESET RELAY
FAN MOTOR
TO TIME BASE OUTPUT AMPL.

1

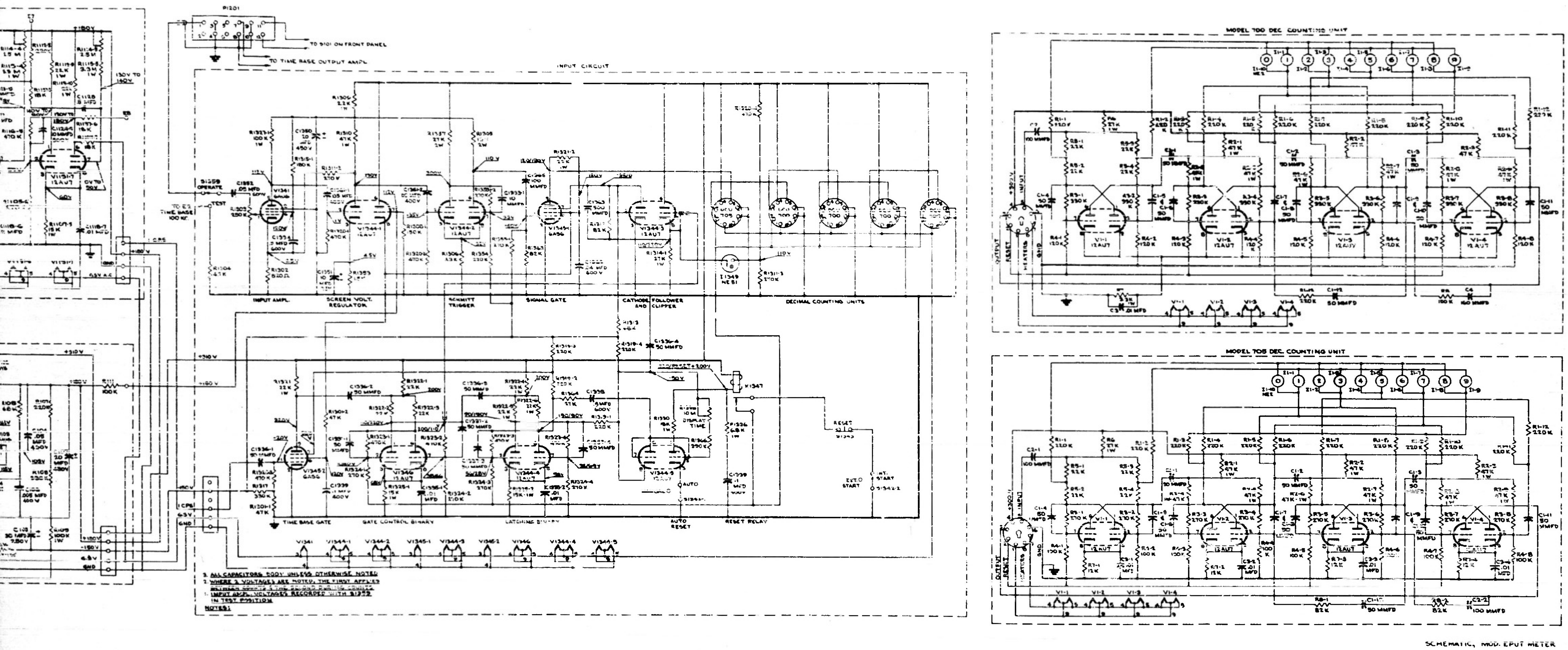


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Figure 25 - Schematic, Berkeley EPUT Meter

the unknown frequency, is displayed until the unit is reset or turned off. The unit may be reset manually or automatically. The automatic reset may be adjusted to display the count (unknown frequency) from about one to three seconds. Since the count requires one second, a one second display means that the unit recycles at a two second rate. This rate permits rapid adjustment of the audio oscillator and calibration of discriminators and galvanometers. Accuracy of the unit is ± 10 parts per million plus one cycle.

7.3 Monitor Panel See Figure 26

The Monitor Panel combines a Millen Oscilloscope, a Measurements Corporation Vacuum Tube Voltmeter, function and selector switches.

Signal output from the receivers and the subcarrier amplifiers may be viewed on the oscilloscope, and measured on the V.T.V.M. Calibration voltages from the audio oscillator may be switched to each channel. Frequency meter may be switched to calibration or received signal for accurate determination of frequency. A recorder control switch is provided to control the recording oscillograph motor.

8.0 Miscellaneous Equipment

8.1 Regulated Power Supply See Figure 27

The regulated power supply furnishes plate and filament power for the subcarrier amplifier.

8.2 Low Pass Filter Chassis See Figure 28

The low pass filter chassis provide mounting and connections for four output channels. Only three are used in this station, each channel being equipped with a low pass filter of 210 cycles cutoff frequency. A switch to bypass the L.P. filter is also provided. The low pass filter frequency response curve is shown in Figure 29.

8.3 Blower Panel See Figure 30

The blower panel contains a centrifugal blower and a dust filter arranged to supply filtered air to two air ducts at the back of the cabinet. Also provided is a master power circuit breaker for control of power to the cabinet and a duplex output receptacle for convenience.

8.4 Blower Units

Two small centrifugal blower units are mounted at the rear of the small cabinet to provide ventilation. In this case the dust filters are mounted on the side of the cabinet.

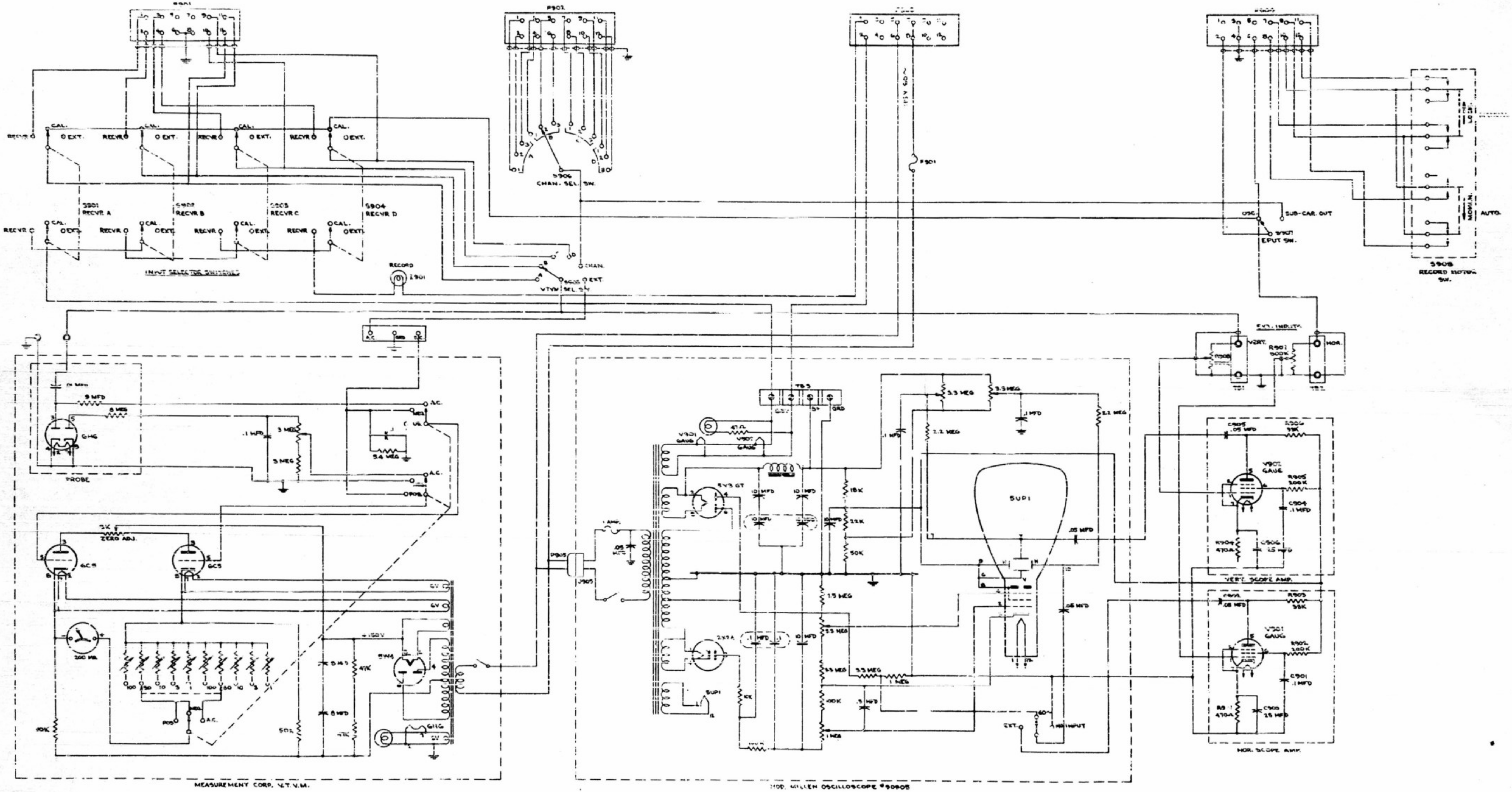


Figure 26 - Schematic, Monitor Panel

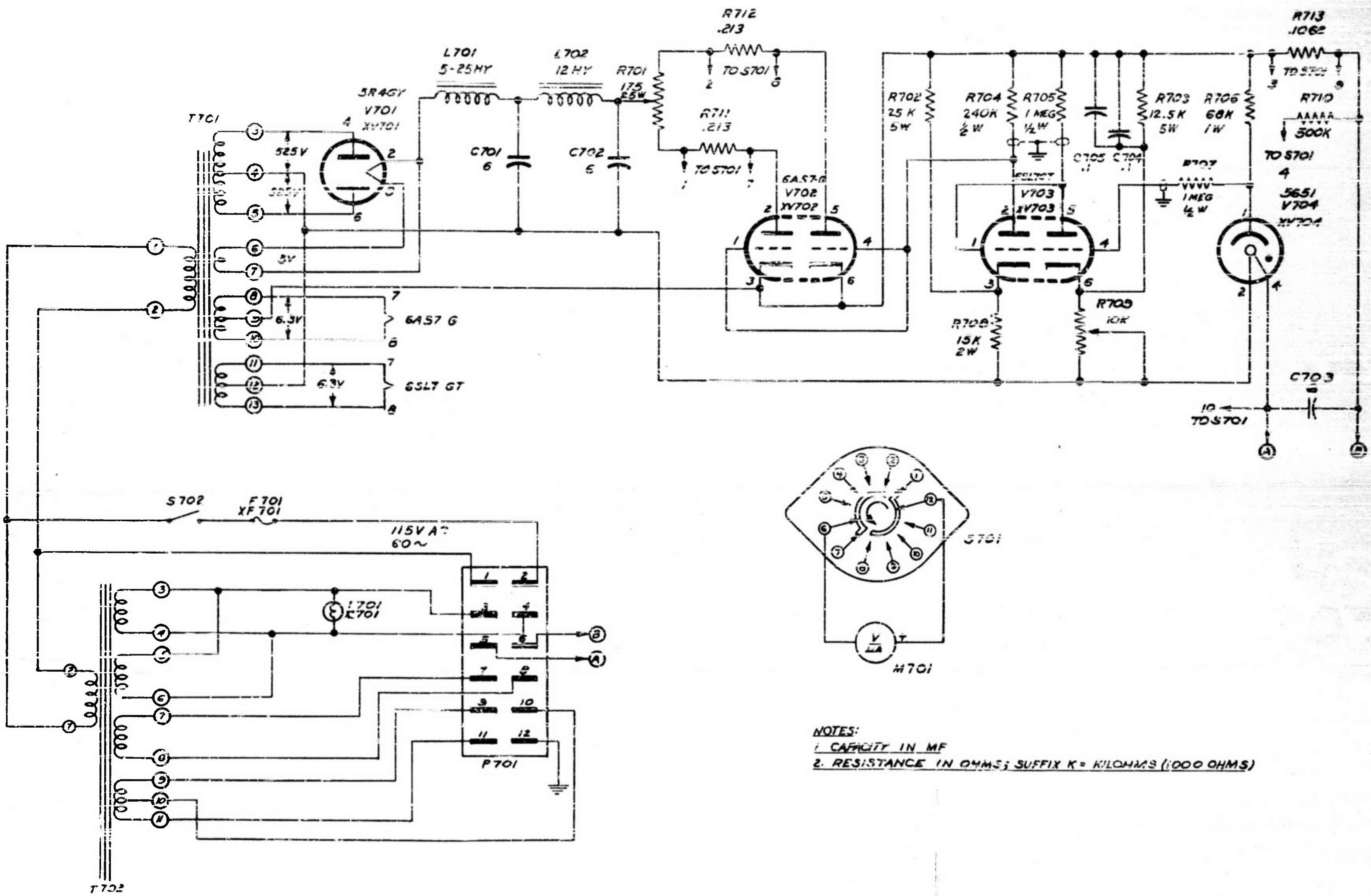


Figure 27 - Schematic, Regulated Power Supply

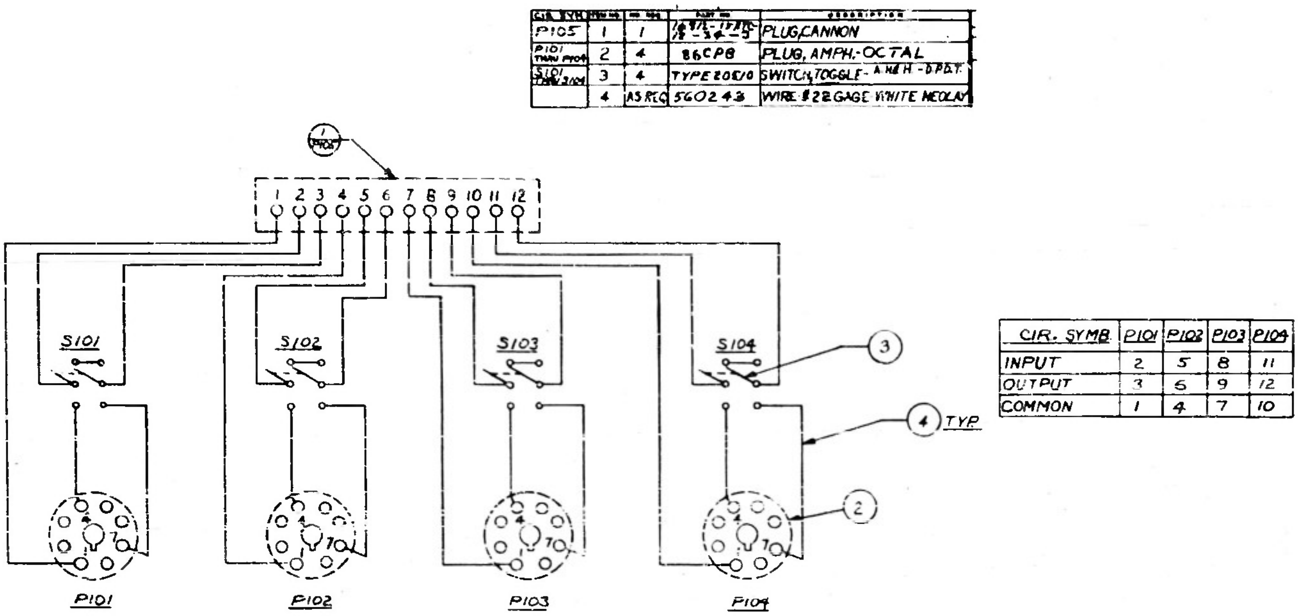


Figure 28 - Schematic, Low Pass Filter Mounting Assembly

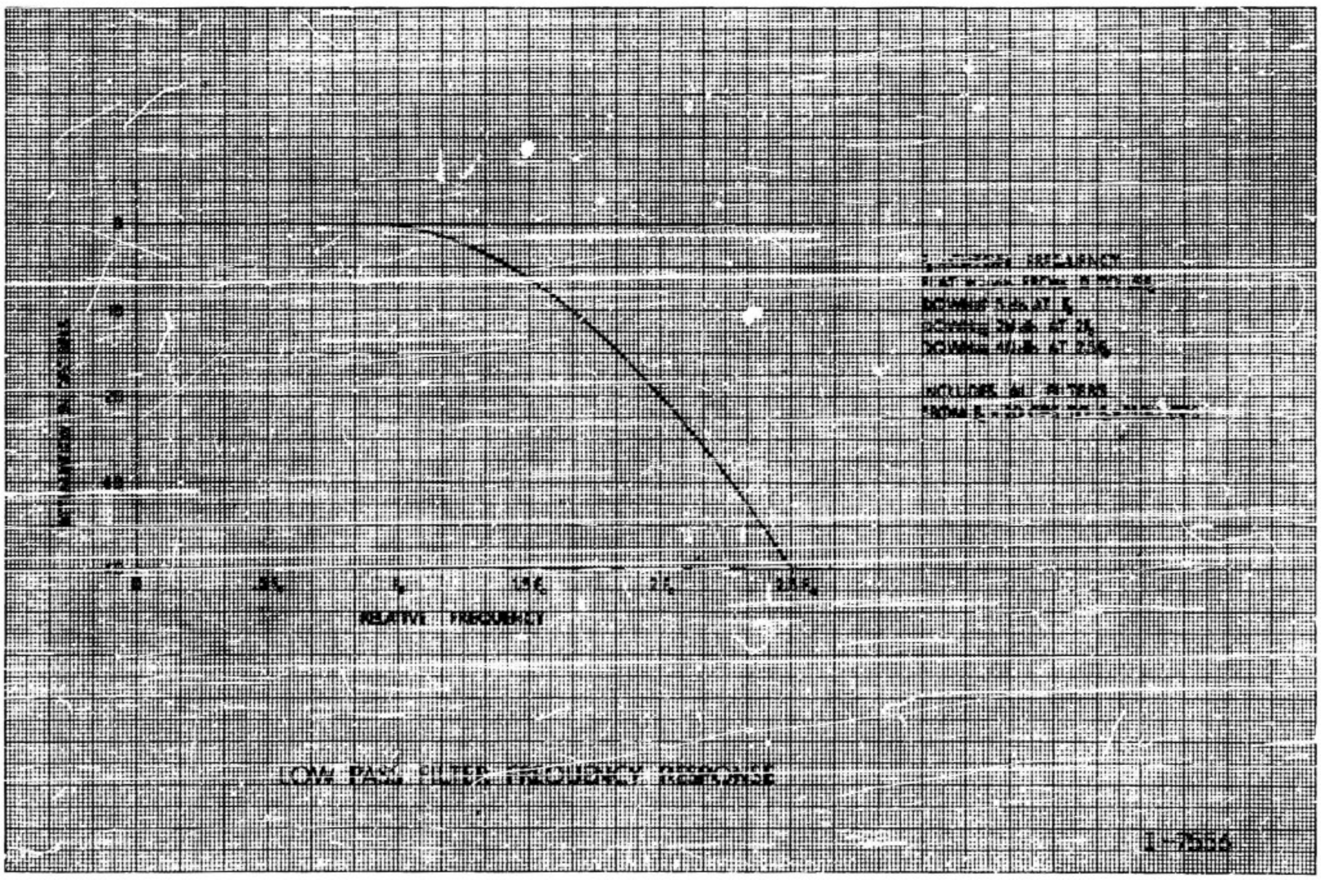


Figure 29 - Low Pass Filter Frequency Response

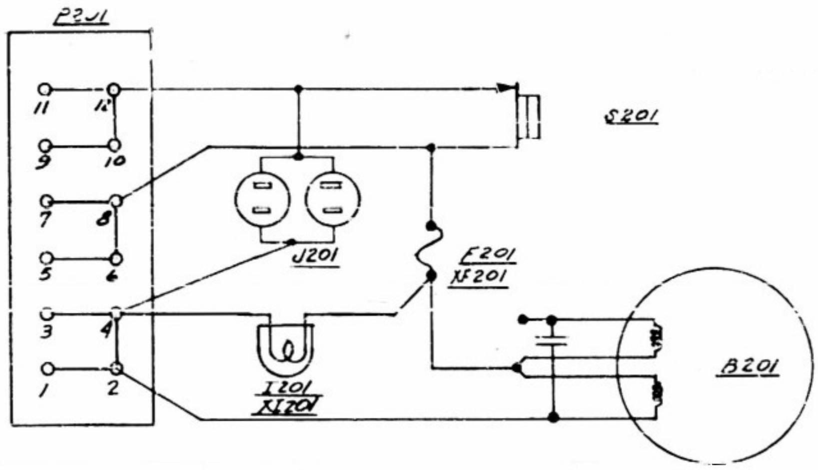


Figure 30 - Wiring Diagram, Panel Intake Blower

CIRC. SYM.	ITEM NO.	NO. REQ.	PART NO.	DESCRIPTION
S401		1	0411	BREAKER- SINGLE POLE HEINEMAN-30 AMP
S402		1	0411	BREAKER- SINGLE POLE HEINEMAN-15 AMP
I401 I402		2	656	LIGHT, PILOT- 115V MAZDA
XI401 XI402		2	147-1201	SOCKET, LAMP, RED JOHNSON-GOTHARD
J401		1	1913	OUTLET, DUPLEX A H&H
		AS REQ.	533285	WIRE-#14GA. WHITE NEOLAY 1 COND. STRAND.
		AS REQ.		WIRE-#10GA. WHITE NEOLAY 1 COND. STRAND.
		AS REQ.	533283	WIRE-#18GA. WH. NEOLAY 1 COND. STRAND

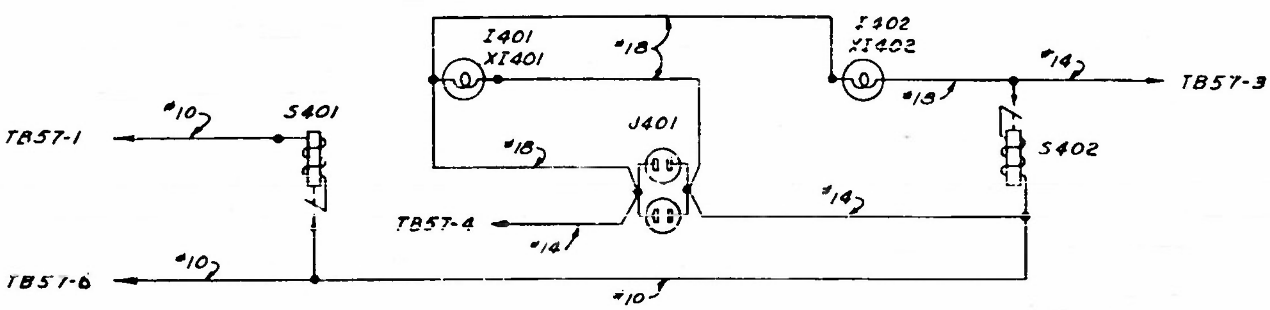


Figure 31 - Wiring Diagram, Master Power Control Panel

8.5 Master Power Control Panel See Figure 31

The master power power panel contains two power circuit breakers; one for the control of power to the control cabinet and the other for control of power to the entire station.

SECTION III

OPERATION

1.0 General

The Bendix Y10980 Telemeter Receiving Stations are installed in special trailers, two stations and a voltage regulator to each trailer.

The stations are entirely separate and can be operated independently or similtaneously. They are mounted along each side of the trailer. The right hand side layout is shown in Figure 2. The left hand side is a mirror image of the right, with the exception of the location of one recorder. For convenience in operation, all controls are located near the recorders.

The equipment is so arranged that under normal operating conditions no external connections, cords or plugs are required for operation or calibration. Calibrate and operate switches are interconnected to indicate by means of a "RECORD" light the proper operating position.

The station is assembled with a separate RF channel for each large cabinet. The RF channel consists of a receiver, subcarrier amplifier, three discriminators and three low pass filters. The first and second subcarrier amplifiershave separate power supply unit mounted in the third cabinet. Accordingly each RF channel can be operated separately or in combination with one or more of the others. The Monitor Panel which includes the calibration switches,VTVM and Scope is mounted in the fourth cabinet. The calibration oscillator, frequency meter and the oscillograph control panel are mounted in the fifth or short cabinet.

In addition each large cabinet is equipped with a Blower Panel which includes a master circuit breaker for the equipment in that cabinet. The short cabinet is equipped with a Master Power Panel which includes a master circuit breaker for the equipment in the cabinet and also the main circuit breaker for the complete station. All circuit breakers and AC switches are equipped with pilot lights to indicate operating conditions.

2.0 Energizing Station

2.1 Turn "ON" main breaker on master power panel; pilot light should indicate.

2.2 Turn "ON" master breaker for each cabinet; pilot light should indicate and blowers should operate.

2.3 Turn "ON" power switches of each unit. All power switches have associated pilot lights which should indicate.

3.0 Check on Station Operating Condition

3.1 Note that all pilot lights are lighted.

3.2 Check that line voltage on voltage regulator is 115 to 120 volts. This voltage may be adjusted at the voltage regulator by means of the voltage control at the left of the meter on its front panel. The regulation or sensitivity control is located to the right of the meter. To set this control properly, turn the control clockwise until the regulator begins to hunt. Then back off the control until the hunting stops.

3.3 Use the built-in testing circuits for rapid checking of the units.

3.3.1 Filter Amplifier: A nine point test switch on the front of each filter amplifier chassis permits checking the plate current to each of the six tubes. In the T position the total plate current to all these tubes is measured. The meter reading should lie between .7 and .9 in each test position.

3.3.2 Regulated Power Supply: The regulated power supply has a testing circuit controlled by the four position switch on the panel. Positions 1 and 2 check the current through each triode of V702. The currents should be approximately equal. Position 3 checks the total plate current output. Position 4 checks output voltage. This should be approximately 250 volts.

3.3.3 Discriminator: Each discriminator also has its own testing circuit controlled by the 6-point panel switch. This circuit checks regulated and unregulated plate currents and voltages. All switch positions should indicate between .7 and .9 on the test meter. The output meter should read center scale, and the input meter should indicate zero when the input control is set to zero input.

4.0 Qualitive Check of Station Performance

4.1 Discriminators

4.1.1 The switching circuit on the monitor panel is arranged to test each subcarrier amplifier with its three associated discriminators. There are four subcarriers amplifier chassis A to D inclusive. The following procedure is given to test A channel and should be repeated for the other channels using the switches for that channel.

4.1.2 On mointor panel turn input selector switch for receiver A (S901) to calibrate, ("CAL and VTVM selector switch (S905) to A. (This connects the audio oscillator to the input of the subcarrier amplifier and bridges the VTVM across the input).

4.1.3 Set audio oscillator to 7350 cycles and adjust the output for 1 volt.

4.1.4 Set gain of all discriminators to maximum.

4.1.5 Adjust gain of No. 1 subcarrier amplifier until input meter on No. 1 discriminator (7.35kc) reads approximately midscale.

4.1.6 Repeat (4.1.5) for #2 channel with the oscillator set at 10500 cycles.

4.1.7 Repeat (4.1.5) for #3 channel with the oscillator set at 14500 cycles.

4.1.8 Swing oscillator frequency from 6000 cycles to 9000 cycles. The No. 1 discriminator output meter should swing to extreme left scale, back to center as 7350 cycles is approached, to extreme right scale and back to center as the frequency is increased. No. 2 and 3 discriminators should indicate zero (center scale).

4.1.9 Continue to increase oscillator frequency and watch the performance of successive discriminators. Each input meter should read, in the proper band of frequencies.

4.1.10 Each meter should swing to extreme left scale to extreme right scale and back to center as frequency is increased and should swing through center at the center frequency of the discriminator. If the discriminator frequency does not stay within limits, the discriminator should be replaced or recalibrated in accordance with calibration procedure given in Section IV.

4.1.11 Repeat complete procedure for group B, C, and D equipment.

4.2 Filter Amplifier

The filter amplifier can be checked separately by reading input and output voltages on the VTVM.

4.2.1 On monitor panel turn input selector switch for receiver A (S901), function selector switch (S907), and VTVM selector switch (S905) to the calibrate position ("CAL").

4.2.2 Adjust the audio oscillator output for a 1 volt reading on the VTVM.

4.2.3 Turn gain control of each channel of the filter amplifier to maximum.

4.2.4 Switch VTVM to output of filter amplifier by switching VTVM selector switch (S905) to "CHAN", and channel selector switch (S906) to channel "A1".

4.2.5 Set the oscillator to 7350 cycles and note output voltage on VTVM. It should measure approximately 12 volts.

4.2.6 Repeat 4.2.4 and 4.2.5 for channels "A-2" and "A-3", using frequencies of 10500 and 14500 cycles respectively.

4.2.7 Repeat 4.2.4, 4.2.5 and 4.2.6 for B, C, and D filter amlifiers.

4.2.8 Response of band pass filters may be checked by slowly swinging oscillator over the appropriate band and noting a decrease in discriminator output at the band edge frequencies.

4.3 Receiver

Turn up the audio gain on the receiver and tune in a signal. Listen for audio signal from the speaker. Observe operation of the two meters on the receiver panel as the tuning dial is rotated through a signal. For turnable receivers only, the zero center meter should swing right, then left, as the receivers is tuned through a carrier. The other meter indicates carrier signal strength. Check antenna system for proper connection and orientation.

4.4 Vacuum Tube Voltmeter

To check the vacuum tube voltmeter, turn input selector switch (S901) for receiver "A" to calibrate position and the VTVM selector switch (S905) to "A". Set the VTVM on AC and as the oscillator output is varied, the VTVM rea ing should vary also.

4.5 Audio Oscillator and EPUT Frequency Meter

The oscillator and frequency meter may be used as a check on each other. Set EPUT selector switch on oscillator. After warmup period, indicated frequency on oscillator should appear on the frequency meter. The frequency meter may also be self checking using an internal test circuit. Set the controls of the frequency meter as follows: Auto-manual on manual, display time, extreme counter clockwise. Start, on Internal Start. Operate-TEST, on test. Sensitivity, extreme clockwise. The frequency meter should display a number every two seconds. The number should be either 00000 or 99999. Move Operate-Test to operate. Set the audio oscillator successively to various frequencies from about 400 cycles to 30,000 cycles. The frequency of the oscillator should be reliably indicated on the frequency meter. Differences of one cycle on successive counts of the same frequency will sometimes occur. This is a normal condition. Adjustment of sensitivity control may be required to obtain satisfactory counting action. The audio oscillator may also be checked for voltage and waveform of output by patching to the VTVM and the oscilloscope.

5.0 Telemetering Pre-operation Program

5.1 Operational Plan

In most cases it will never be possible to repeat an operation. The greatest possible care and precaution must therefore be exercised in preparing for, and in operating the station during the operation. The most experienced station operator will occasionally overlook some important detail. Therefore, there are a number of precautions which should be taken.

There must be two qualified station operators present, prior to and during the operation. Each man must have a check list of operations and adjustments for which he is responsible. He must check off each item on the sheet as he makes the adjustments. These sheets must be dated, signed, and provide a permanent record for future reference, of the station operation.

A complete and detailed operation plan must be prepared prior to the flight. This plan should show every step and operation to be made, preparatory to the launching, and may cover a period of several hours, depending upon the amount of preparation required. The times of major operations must be shown. As a part of the flight plan, detailed application information showing galvanometer setup must be prepared. Because the telemetered functions, the recording medium, and the recording galvanometers are intimately related, this must be prepared by those in charge of the telemetering station, in close cooperation with those in charge of the project. A knowledge of what functions are to be telemetered, their amplitudes, and frequencies or rates of change, is required. Familiarity with the characteristics of the galvanometers, such as sensitivity, element frequency response, and damping characteristics is necessary, in addition to a knowledge of the setting up of the galvanometers in the recording oscillograph. Also, experience in the use of recording mediums, is required. Information regarding films and papers, types, speeds, and exposure characteristics is obtainable from the manufacturers. Paper for telemeter recording is manufactured by Eastman.

Film for telemeter recording is manufactured by Eastman, Ansco, and DuPont. Ozalid paper is obtainable for making paper records from films.

5.2 Station Preoperation Checkout

To minimize the possibility of telemetering failure, resulting from station operating errors, the following checkout procedure is suggested. Additions or modifications may be necessary in order to conform to the firing schedule, or to special requirements of a particular flight. Operators must check each item deliberately, regardless of previous checks or inspections.

5.2.1 Not later than minus one day preceding test.

5.2.1.1 Check all reference circuits such as zero time, range time, and 1 cps time base signals.

5.2.1.2 Check communication facilities.

5.2.1.3 Inspect antenna system. Check all coaxial connectors. Check movement and orientation of rotatable antennas and measure leakage resistance.

5.2.1.4 Check power facilities. Check fuel, lubrication and battery levels, PE-95K engine-generator. Check frequency and voltage output of unit under full load conditions.

5.2.1.5 Check all connections, switches and fuses.

5.2.1.6 Check performance of telemetering receivers.

5.2.1.7 Check test meter readings on filter amplifier chassis.

5.2.1.8 Check operation of all discriminators for:

Correct setting of sensitivity control (Full scale meter deflection at band limits.)

Linearity and zero deflection at band center-frequency.

Limiting action.

Correct test meter readings.

5.2.1.9 Adjust oscillograph recorders for desired film or paper speed. Check take-up system.

5.2.1.10 Adjust recording lamp intensity to correct value for paper or film and recorder speed.

5.2.1.11 Load and install oscillograph magazines. (Run five-foot leader while observing paper feed operation. Load at least one spare magazine per trailer.

5.2.1.12 Check operation oscillogram numbering device.

5.2.1.13 Adjust galvanometer band center frequency setting and polarities in accordance with predetermined band requirements, as given in the oscillograph set-up forms for a specified operation. Adjust input attenuators to provide desired galvanometer deflections.

5.2.1.14 Check galvanometer band end limit points for equal distance from band center frequency point.

5.2.1.15 Determine that all spare materials and equipment are on hand and ready for immediate use.

5.2.1.16 Compile a detailed RECEIVING STATIONS OPERATIONAL PLAN.

5.2.2 At approximately -5 hours, turn on all equipment and check for proper operation at frequent intervals.

5.2.3 At approximately -4 hours --

5.2.3.1 Check oscillograph paper feed.

5.2.3.2 Check operation of timing lines motor.

5.2.3.3 Check recording lamp voltage and operation.

5.2.3.4 Check galvanometer identification system operation.

5.2.3.5 Make preliminary balance on discriminators and check band center frequency setting, polarity and excursion of galvanometers.

5.2.3.6 Check setting, polarity and excursion of zero time, functions range time, and 1 cps time base galvanometer traces.

5.2.3.7 Check inter-trailer communications.

5.2.3.8 Fill out oscillogram identification record in preparation to making entries through the test.

5.2.4 At approximately -3 hours.

5.2.4.1 Make signal strength calibration on all receivers using the following steps: 0, 5, 10, 25, 50, 250, and 500 microvolts.

5.2.4.2 Obtain accurate time check and synchronize all clocks.

5.2.4.3 Scan frequency spectrum to determine possible presence of interfering signals.

5.2.5 At approximately - 2 hours.

5.2.5.1 Recheck communication facilities.

5.2.5.2 Recheck engine-generator performance.

5.2.5.3 Recheck performance of all receiving station equipment.

5.2.5.4 Recheck all reference signals.

5.2.5.5 Recheck antenna system.

5.2.5.6 Recheck clock time and clock synchronization.

5.2.6 At approximately - 1 hour

5.2.6.1 Recheck zero balance with center test switch operated on each discriminator.

5.2.6.2 Make final center frequency (zero output voltage) balance of each discriminator, using fine balance control with center frequency applied. Use galvanometer trace as indicator.

5.2.7 At approximately - 45 minutes.

5.2.7.1 Calibrate all discriminators, making three recordings; +7.5% of center frequency, center frequency, and -7.5% of center frequency for each subcarrier frequency used.

5.2.7.2 Scan frequency spectrum for interfering signals.

5.2.8 At approximately - 15 minutes (Final equipment check)

5.2.8.1 Recheck all equipment operation as time permits.

5.2.8.2 Turn on the telemetering receivers.

5.2.8.3 Audio oscillator gain control in off position.

5.2.8.4 Check presence of reference signals.

5.2.9 At - 5 minutes (Approximate time of receiving signals.)

5.2.9.1 Set RCVR-CAL selector switch to RCVR.

5.2.9.2 Turn on all galvanometer switches.

5.2.9.3 Rotate antennas for best signals on all receivers.

5.2.9.4 Standby to record.

5.2.10 At approximately - 1 minute

5.2.10.1 Begin continuous recording of oscillograph recorder until loss of all signals or until a minimum of 25 feet of paper remains for a post-test calibration.

5.2.11 At end of test.

5.2.11.1 Calibrate all discriminators using the nine-point calibration as outlined in the Receiving Station Calibration section of this manual.

6.0 Calibration and Data Reduction Procedures

6.1 Receiving Station Calibration

Calibration of the receiving station is accomplished by feeding a series of known audio frequency signals into the appropiate station discriminators. By feeding a series of nine frequencies for each sub-carrier channel into the discriminators, a series of nine voltage out-puts, and consequently nine galvanometer deflections will be obtained and hence a calibration curve of frequency versus galvanometer deflection will be obtained. The values of the calibrating frequencies used for each of the allotted subcarriers are as follows:

7.35kc	10.5kc	14.5kc
6800	9700	13,400
6900	9800	13,600
7000	10,000	13,900
7150	10,200	14,200
7350	10,500	14,500
7550	10,800	14,800
7700	11,000	15,100
7800	11,200	15,400
7900	11,300	15,600

A short recording is made on the oscillograph for each different calibrating frequency fed into the discriminators. Since the output of each discriminator is connected to galvanometer in the oscillograph, each change in the frequency of the signal introduced to the discriminator results in a corresponding change in the deflection of that particular galvanometer's trace on the recording paper. After these records are developed, the galvanometer deflection of each channel is measured from a reference trace and recorded for each input frequency to the discriminator. Thus a discriminator calibration curve of galvanometer deflection versus frequency can be plotted to be used in data reduction.

6.2 Pickup Calibration

The various types of telemetering pickups are used as the frequency-determining component of an oscillator. By applying accurately measured function values to the pickup, a calibration curve of function value versus oscillator frequency can be obtained. When the pickups are installed in a missile, the subcarrier oscillators are padded to the frequency taken from the calibration curve for the function value which exists (or applied) on the pickup in order for the calibration curve to apply.

6.3 Data Reduction

After each telemetered flight, the oscillograph record is processed and marked, and the important task of data reduction begins. The data reduction procedure consists of three fundamental steps:

6.3.1 A record calibration curve is prepared by combining the discriminator calibration (trace displacement versus frequency) and the pickup calibration curve (frequency versus function value). This new calibration curve, therefore, indicates trace displacement as a function of the quantity under measurement.

6.3.2 The displacement of each trace from the fixed reference line is measured at all significant points throughout the length of the record. The displacement measurements are tabulated and plotted on graphs which show the variations in measured quantity against time.

6.3.3 The application of appropriate correction factors to the reduced data is sometimes necessary. The magnitude and nature of these corrections will depend upon a knowledge of (a) the stability of the discriminators and recording equipment, (b) the characteristics of the pickups, and (c) the natural frequencies and coefficients of damping of the recording galvanometers.

SECTION IV

MAINTENANCE

1.0 General

All units in the receiving station are of panel and chassis construction. For convenience in maintenance or inspection all units are equipped with slides which enable them to be pulled out clear of the cabinet. A spring operated stop pin prevents the unit from being inadvertently pulled completely out. To remove the unit from the cabinet it is only necessary to release this stop pin. Connections are made through one or more multiconductor plugs mounted on the rear of the chassis, which engage with receptacles mounted in the cabinet. Plugs and receptacles disconnect when units are pulled forward.

Units are held locked in position by means of a hinged bar which folds over the edge of the front panel and is held locked by fasterners, permitting quick unlocking.

For better accessibility some of the units can be tilted 45° or 90° when in the forward position; they are held in position by means of a spring latch on the side of the chassis, which can be released to tilt the chassis. For testing or trouble shooting, a multiconductor cable with connector is supplied which enables the unit to be connected in the out position. Connections from the receptacles in the cabinets are brought down to "Crablok" terminals strips mounted on the bottom of the cabinet. These connections are shown in the following drawings:

Receiver Cabinet	Y 12623	Figure 32
Monitor Cabinet	Y 12624	Figure 33
Control Cabinet	Y 12625	Figure 34

Intercabinet connections are between these terminal strips and are shown on the following drawings:

Cabinet A to B	Y 12626	Figure 35
Cabinet B to C	Y 12627	Figure 36
Cabinet C to D	Y 12628	Figure 37
Cabinet D to E	Y 12629	Figure 38
Cabinet E to Oscillograph	Y 12630	Figure 39

In addition for convenience in testing or trouble shooting a terminal designation diagram is shown in Figure 40.

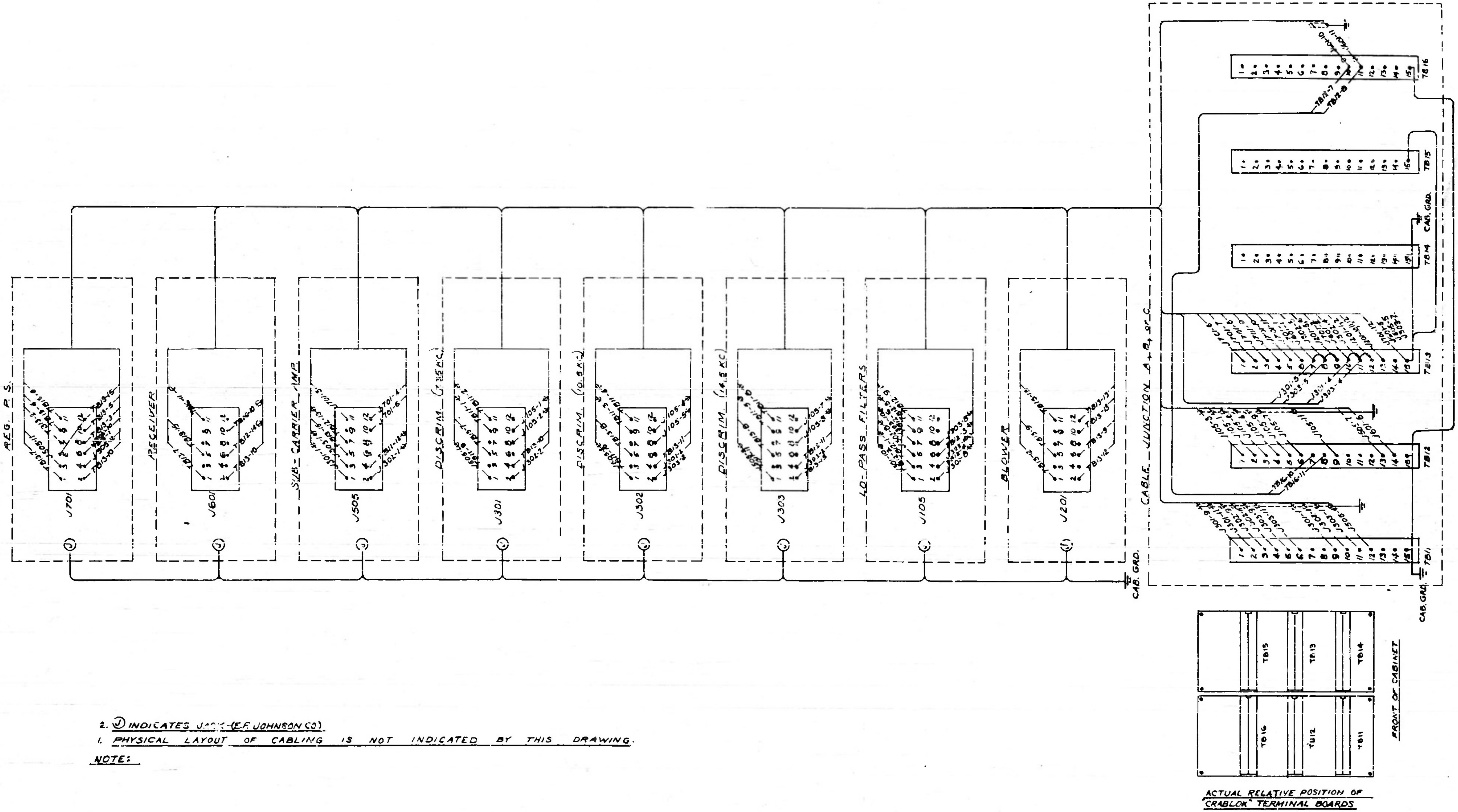
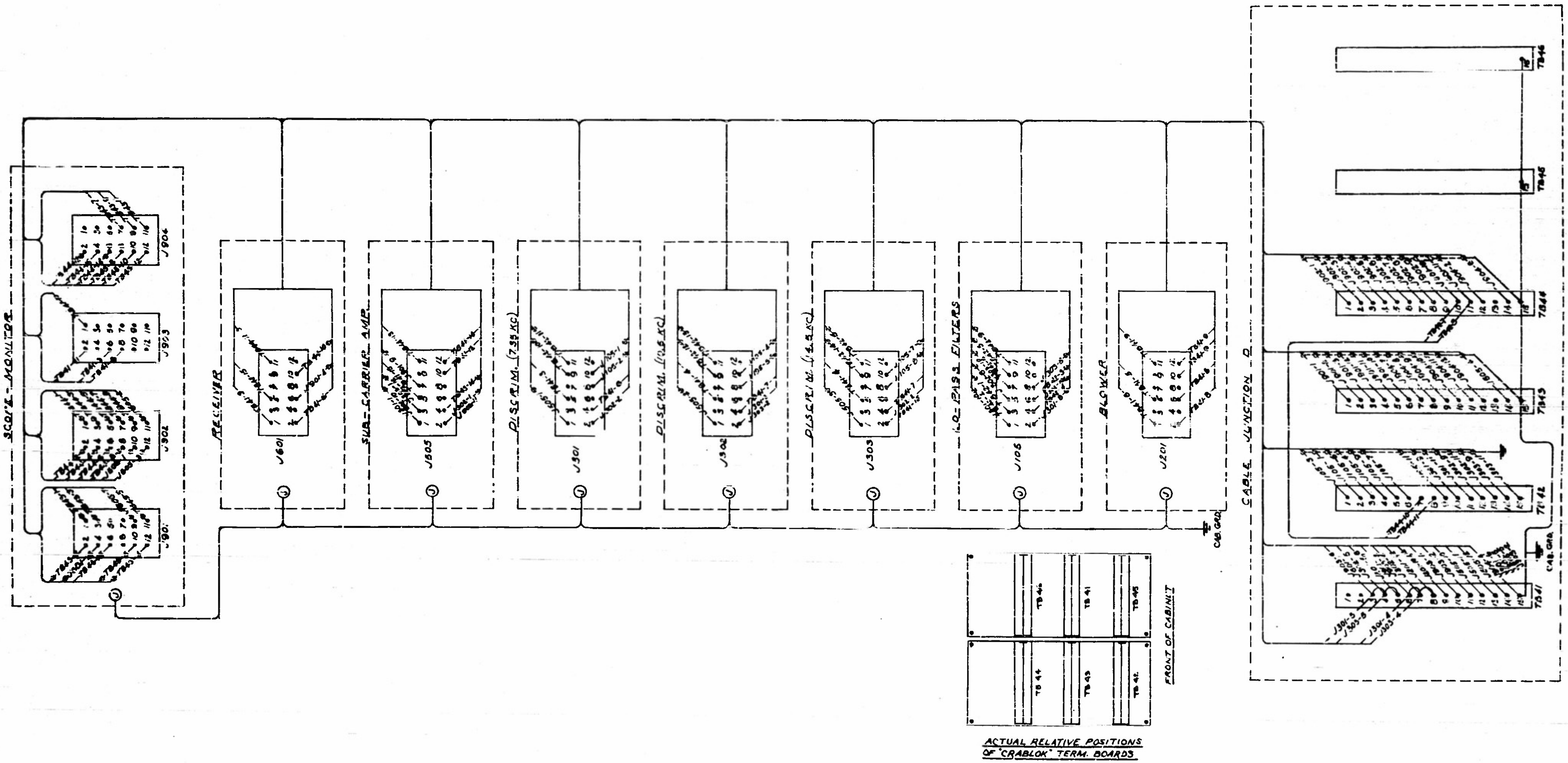


Figure 32 - Wiring Diagram, Receiving Cabinet (A, B and C)



NOTE:
1. (J) INDICATES JACK - (E.F. JOHNSON CO.)

Figure 33 - Wiring Diagram, Monitor Cabinet (D)

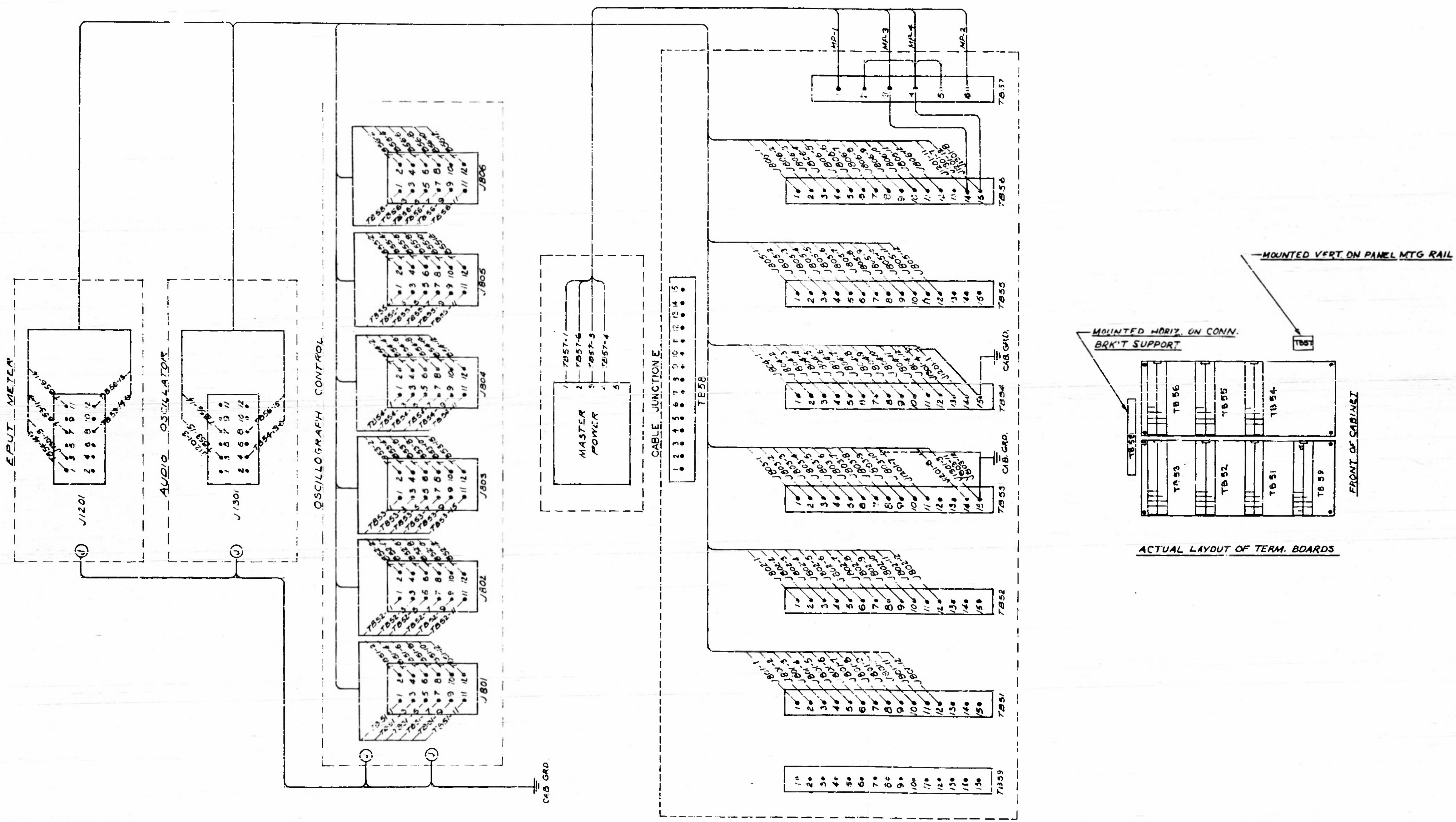


Figure 34 – Wiring Diagram, Control Panel (E)

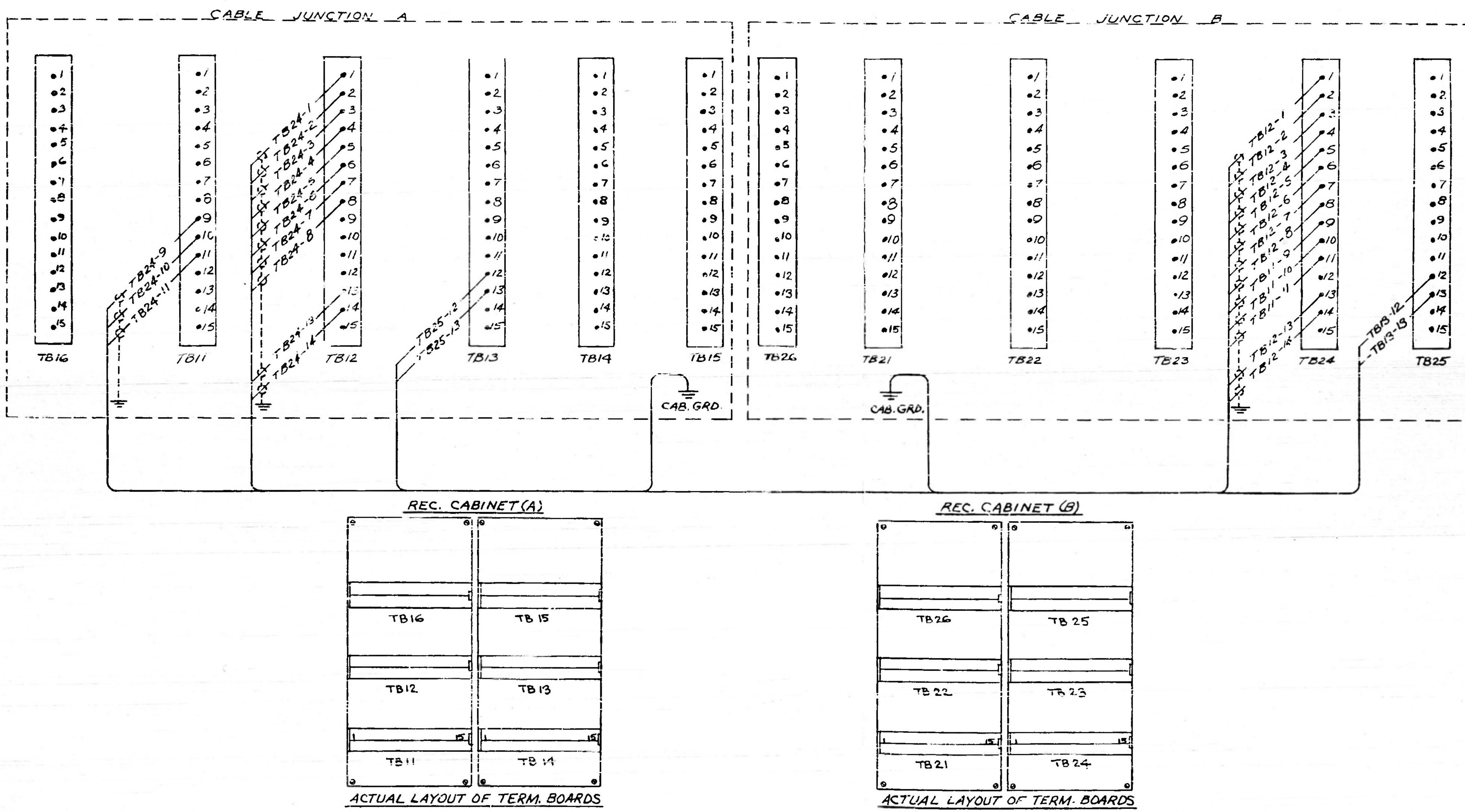


Figure 35 - Wiring Diagram, Inter-Cabinet (A - B)

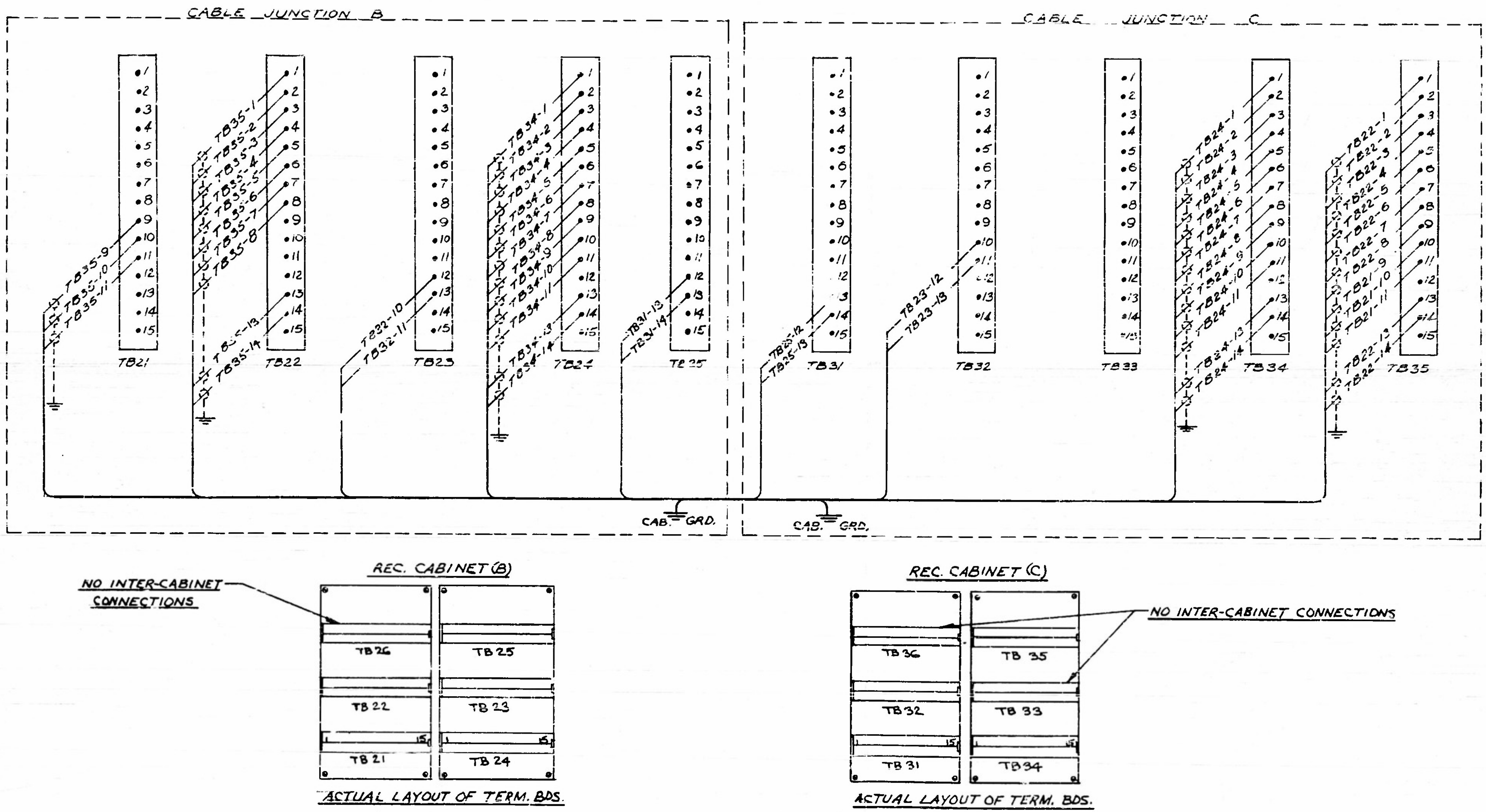


Figure 36 - Wiring Diagram, Inter-Cabinet (B - C)

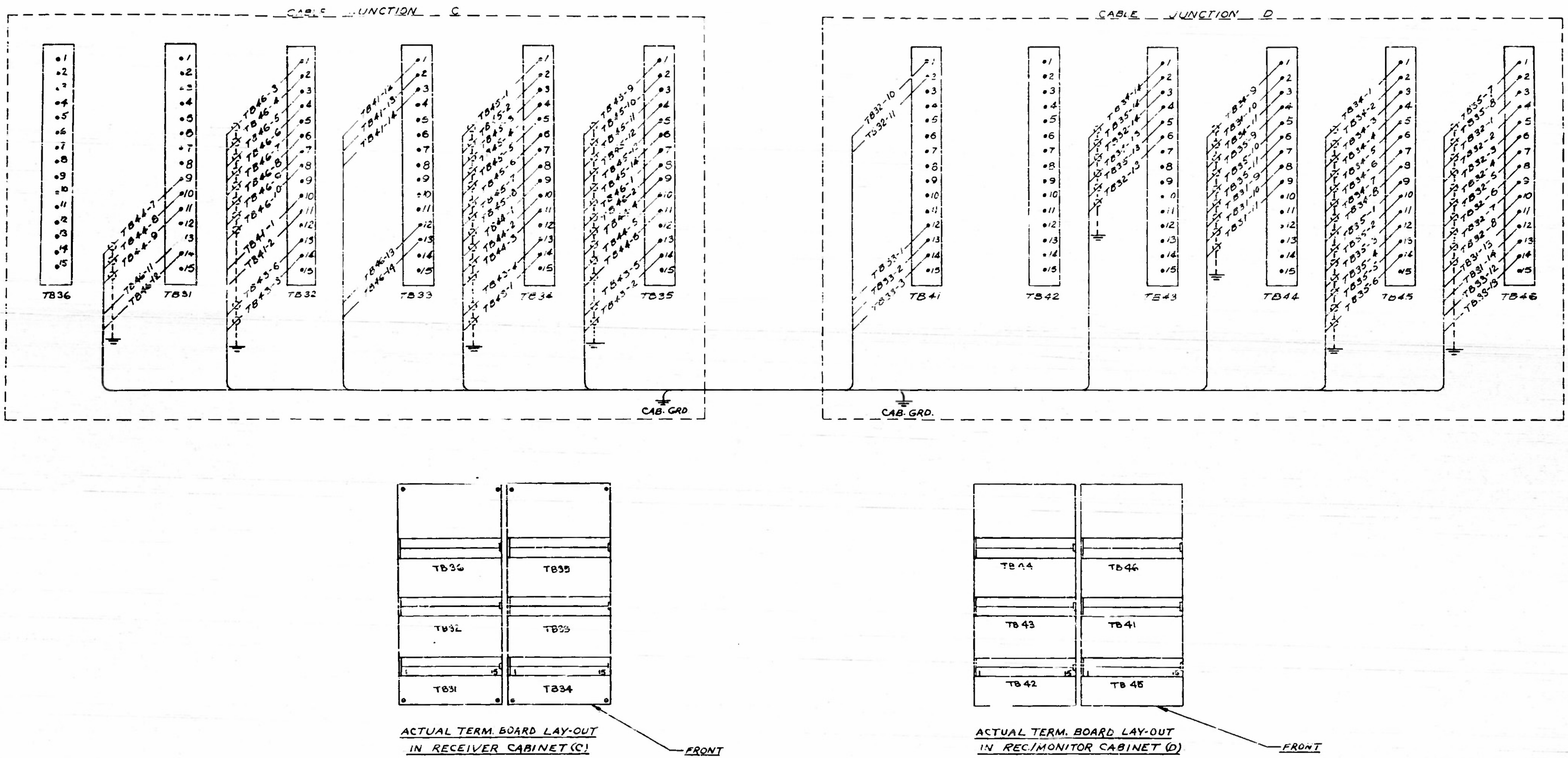


Figure 37 - Wiring Diagram, Inter-Cabinet (C - D)

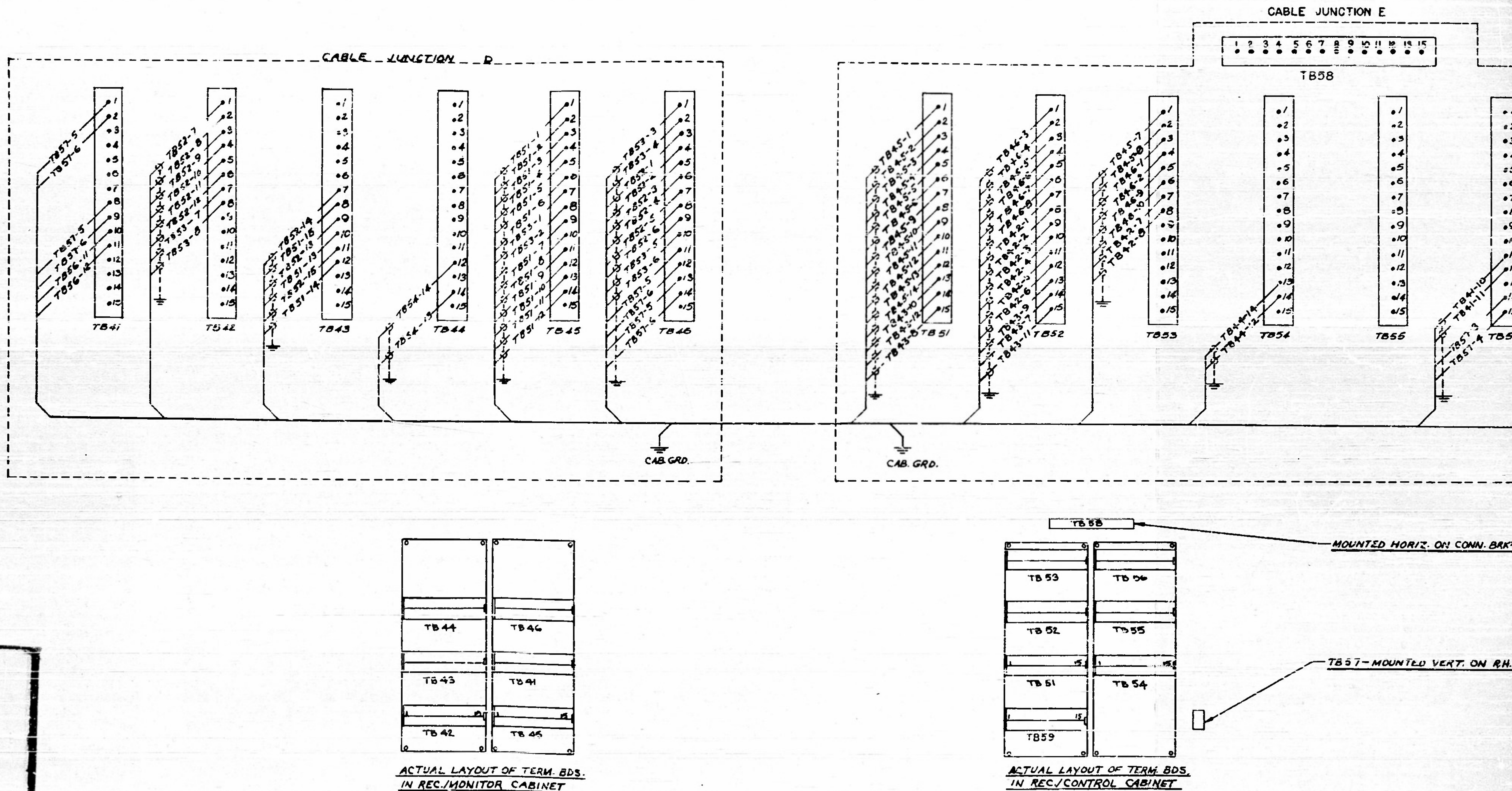
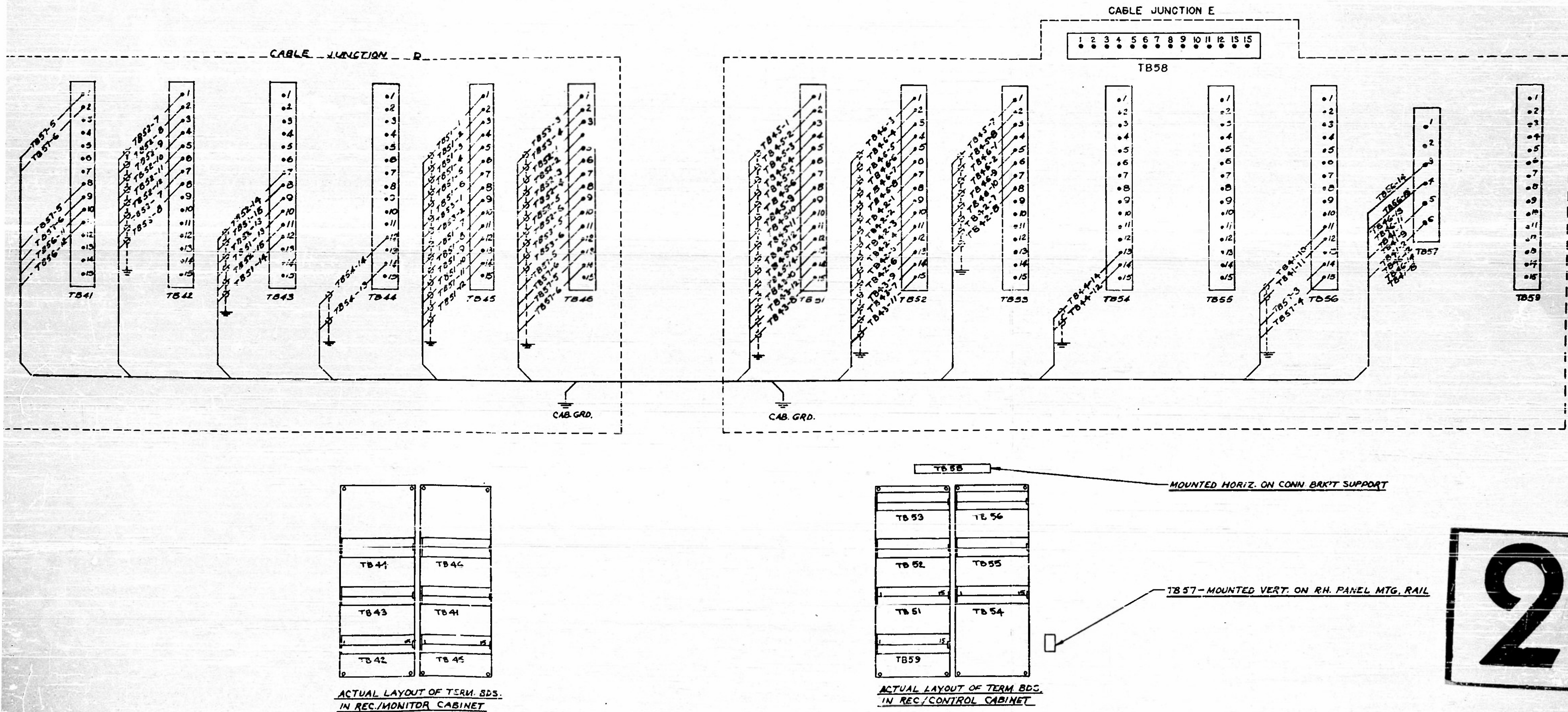


Figure 38 – Wiring Diagram,



2

Figure 38 - Wiring Diagram, Inter-Cabinet (D - E)

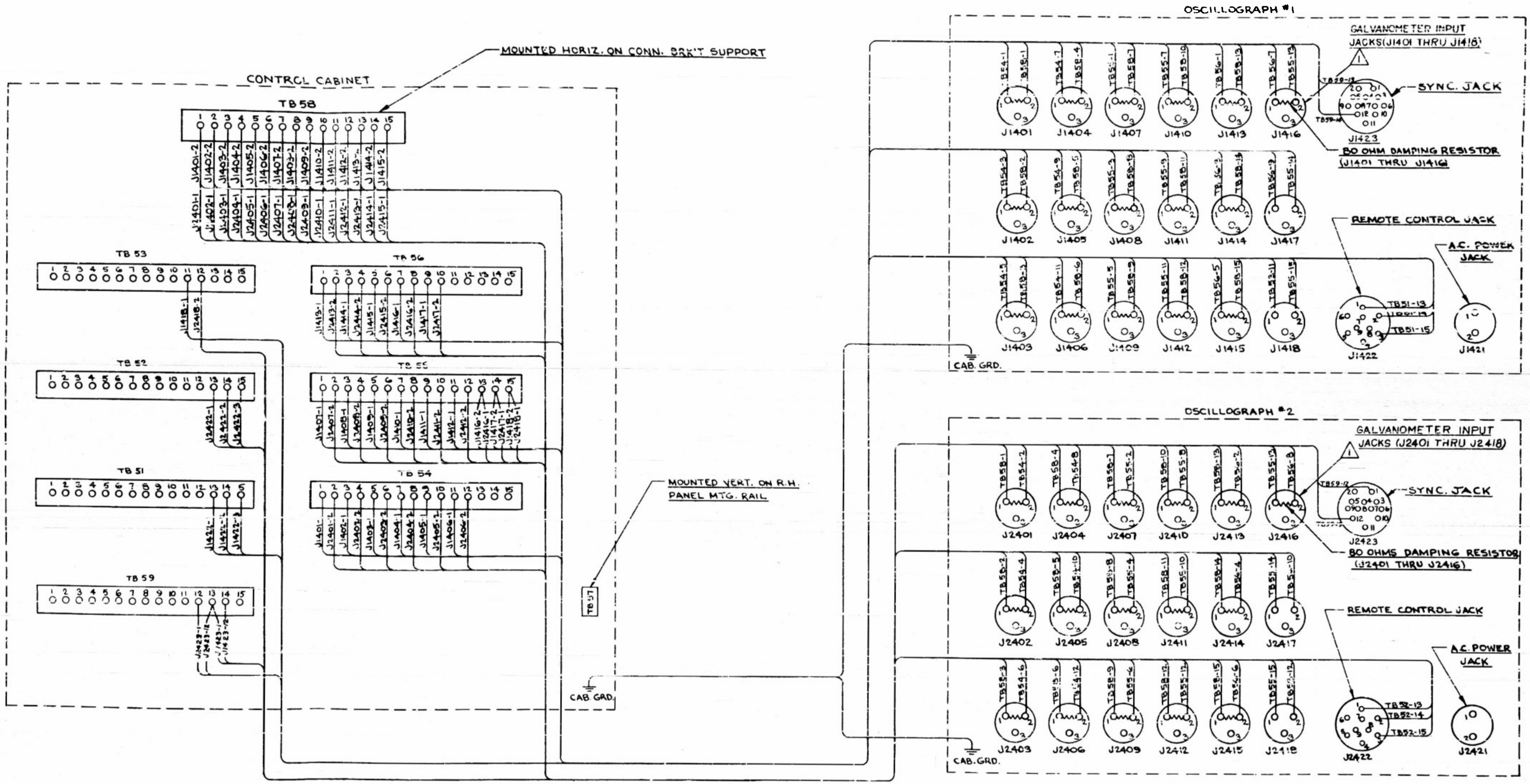
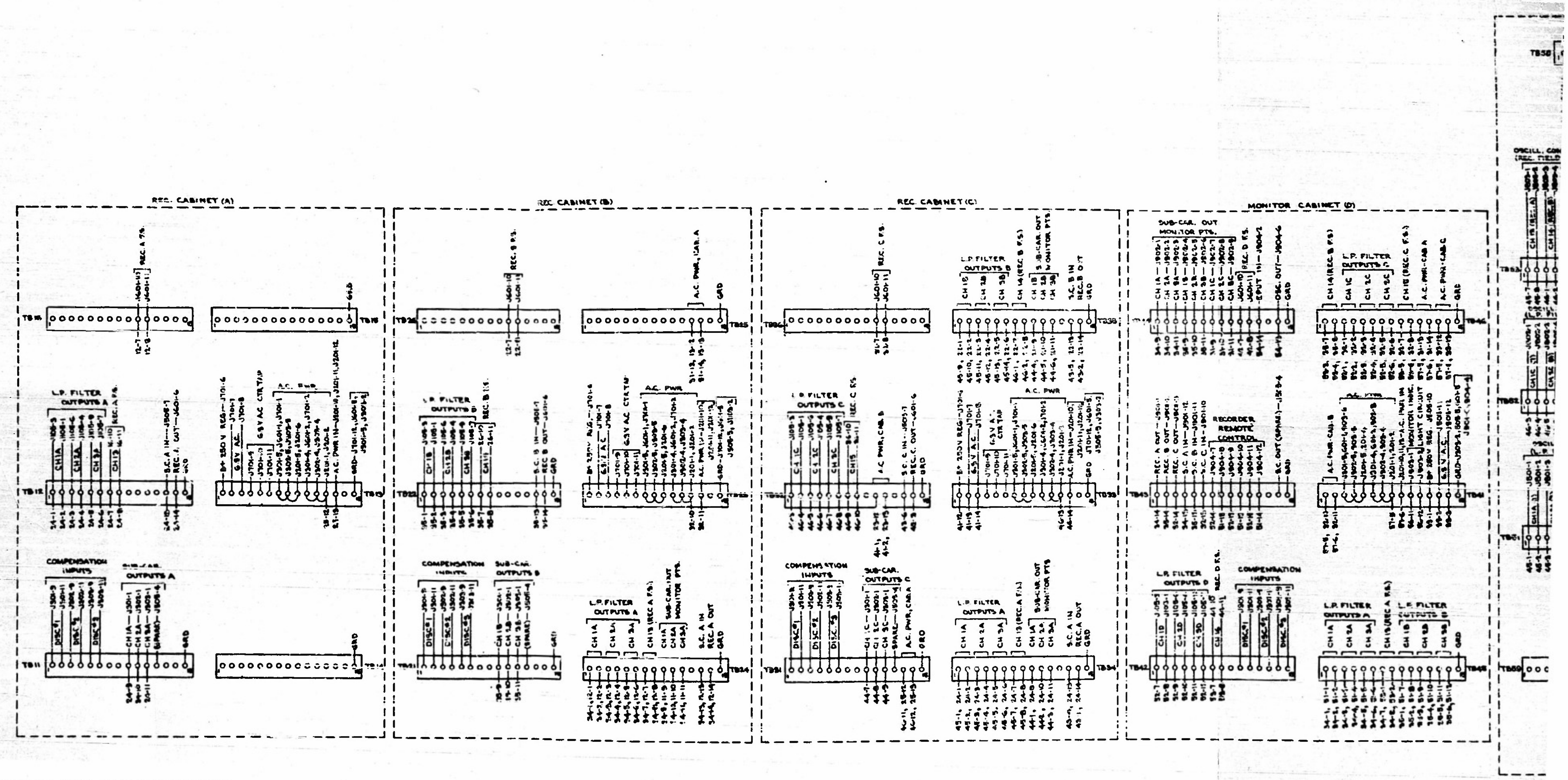


Figure 39 - Wiring Diagram, Inter-Cabinet (E-Oscillator)



NOTES:
1. IN GENERAL, FUNCTIONS & DESTINATIONS OF INNER-CABINET WIRING ARE INDICATED ABOVE EACH TERM. BD. WHILE DESIGNATIONS BELOW INDICATE INTER-CABINET & EXTERNAL WIRING.
2. DESIGNATION NOS. WITH NO LTR. PREFIX INDICATE TERMINAL BOARD CONNECTIONS.
5. LEGEND: S.C. - SUB-CARRIER AMP.
L.P. - LOW PASS (FILTER)
F.S. - FIELD STRENGTH SIGNAL
4. F.A CONNECTIONS TO RECORDING OSCILLOGRAPHS SEE WIRING DIAGRAM V12690

Figure 40 – Terminal B
Receiving

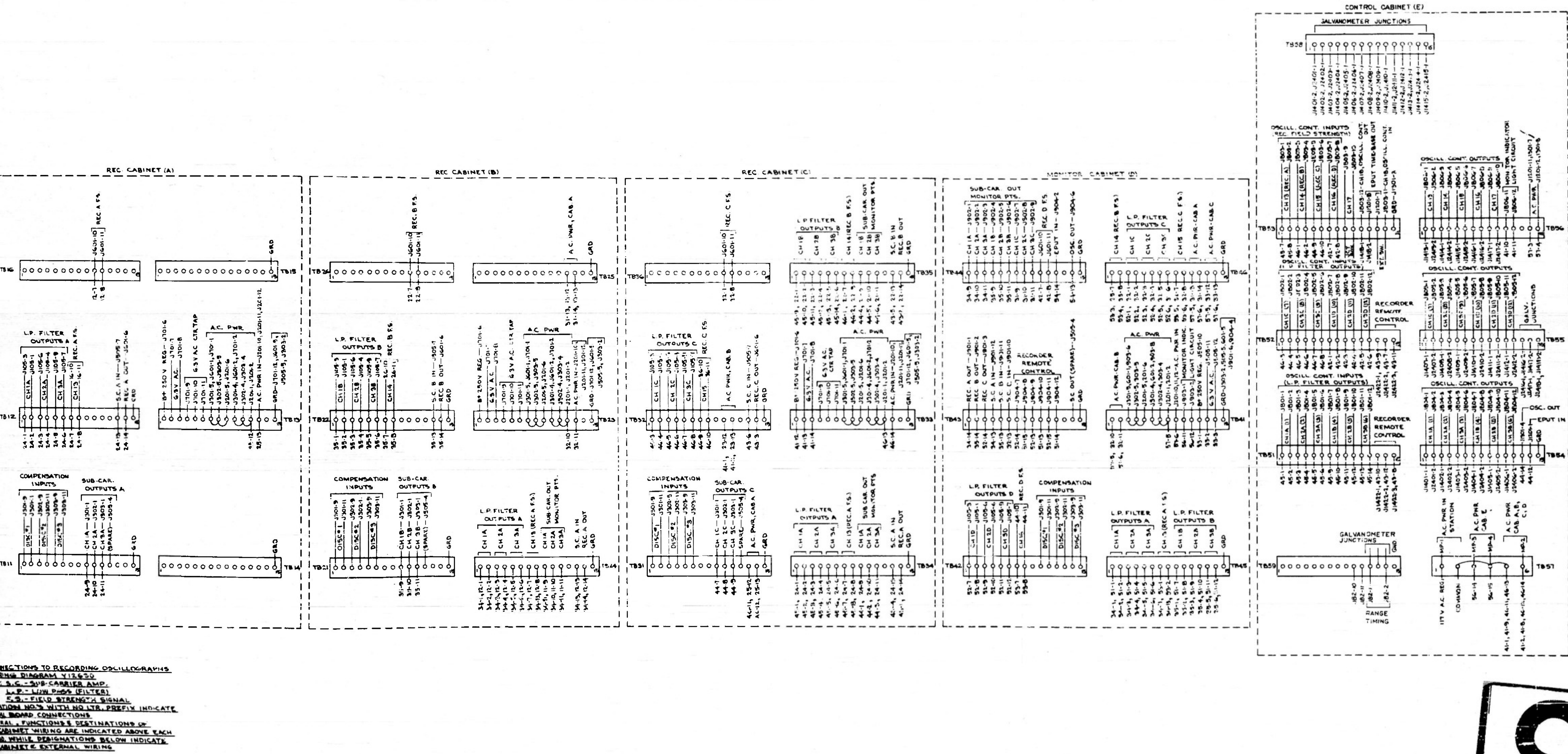


Figure 40 – Terminal Designation Diagram, Receiving Station

2.0 Model 167-E Clarke Receiver

2.1 General

The Model 167-E special-purpose receiver is designed as terminal equipment for a telemetering system employing a radio link and receiving intelligence in the form of frequency-modulated signals consisting, for example, of one or more frequency-modulated subcarriers. Over the specified tuning range of 180 to 260 mc the antenna input impedance of the 167-E receiver is approximately 75 ohms. The circuit is arranged for single or unbalanced input. The antenna is connected to a SO-239 type jack, located on the rear apron of the chassis. The basic tuning element around which the frontend assembly is designed is a standard Mallory S-4 Spiral Inductuner. A stop assembly is arranged to restrict rotation of the spiral tuner to the last one and one-quarter clockwise turn of its normal 5-turn rotation. The signal frequency is tuned by L101 and the input capacity of the 6J4 plus wiring capacities. A double-tuned band-pass is used between the 6J4 R.F. amplifier and the 6AK5 mixer to provide high image I.F. rejection. The coupling between the two circuits is capacitive and consists of C104, C105, and C106. C105 is adjustable to provide accurate control of bandwidth. The 6J4 R.F. stage is operated at maximum gain at all times to produce maximum signal-to-noise ratio. Bias for the 6AK5 mixer is derived from the local oscillator. This method produces more uniform operation at all frequencies and allows for considerable variation in local oscillator amplitude due to tube aging, A.F.C. pulling, etc. This also allows direct grounding of both cathode terminals to minimize cathode lead inductance and produce maximum input resistance so necessary at these frequencies. The mixer is pentode connected to prevent distortion of I . F . response due to changes in its plate resistance which may be caused by variation of local oscillator amplitude, tube aging, etc. A rather unconventional oscillator configuration is used due to the high frequency of operation and the necessity for A.F.C.

The oscillator circuit used is essentially a Colpitts with an unbypassed resistor connected in the cathode to damp tube resonance. The A.F.C. reactance tube is connected directly across the oscillator. Phase shift is produced in the grid by the series combination of grid-plate capacity and a 27 ohm carbon resistor. Input resonance in the reactance tube is not damped by the cathode resistor since the grid circuit must return to the cathode. The use of a small resistor (27 ohms) in the grid circuit extends the operating range through 285 mc. A.F.C. may be turned on or off or supplied from an external source by a front-panel control.

The R.F. unit is a complete assembly with input and output signals available through coaxial connectors and with power and A.F.C. leads through a small cable.

2.2 I.F. Amplifier

The I.F. amplifier is a separate, completely shielded assembly. It is conventional in most respects. Two high-gain stages using 6CB6 tubes are followed by a 6CB6 first limiter and a 6AK5 second limiter. A 6AL5 is used on a balance phase discriminator.

The discriminator circuit is a conventional balanced phase shift type. In order to obtain balance the secondary is bifilar wound and link coupled to the primary. This link is adjusted in production for minimum distortion. For stability reasons a self-resonant choke L108 is connected to the output lead.

Signal level monitoring is provided by sampling the developed voltage at both limiter grids. The second limiter developes a voltage proportional to the input signal up to about 10 uv. About this level the voltage on the second limiter is constant, and a voltage proportional to the logarithm of the input exists at the first limiter. These voltages are combined to produce an easily read logarithmic signal-strength scale.

2.3 Output and Monitoring

A 12AU7 (V109) is used as a d.c. bridge to indicate discriminator output for tuning purposes and as a direct coupled video amplifier. V110 is used as a cathode follower output stage and is direct coupled from the video amplifier. The output is 10-15 volts RMS for $\pm$125 kc deviation.

A conventional two-stage amplifier with built-in loudspeaker is provided for monitoring.

2.4 External Signal Strength Recording

Provision has been made for supplying 10 ma to record variations in signal strength. This signal is the combined plate and screen currents to V104, and it is adjusted to 10 ma with no signal by varying the screen voltage with R150. The signal thus obtained is reverse readings; i.e., 10 ma is obtained with no signal, and minimum current is obtained at maximum signal. This current can be recorded on channels 13 to 16 inclusive.

2.5 Alignment Procedure

2.5.1 Align discriminator.

2.5.2 Align I.F. transformers.

2.5.3 Check dial stops and mechanism.

2.5.4 Adjust oscillator

2.5.5 Align R.F. amplifier

2.5.6 Repeat adjustment of local oscillator

2.5.7 Calibrate signal-strength meter

2.6 Discriminator Alignment

In preparation for alignment of the discriminator transformer T105 (at left end of I.F. assembly as receiver is viewed from the front), remove the second limiter 6AK5 tube from the assembly and note the reading of the center frequency or zero center meter. If it is off center, it should be centered by means of the adjustment (R153 potentiometer) on the rear apron of the chassis. Difficulty in readily securing an exact center reading is indicative of a defect in the 6AL5 tube (V108), the 12AU7 tube (V109), or their associated components, and must be corrected before proceeding further. Other steps are as follows:

2.6.1 Remove oscillator tube to prevent mixing at signal generator harmonic frequencies.

2.6.2 Set receiver dial to 200 mcs.

2.6.3 Set signal generator to 21.4 mcs and connect to antenna terminals. If sufficient output indication is not secured, connect to mixer grid instead.

2.6.4 Connect high-resistance voltmeter (Volt Ohmyst type) to second limiter grid return (orange lead from I.F. assembly connected to tie point T-111). The signal-strength meter may be used as an output indicator with equal accuracy.

2.6.5 Set generator to produce approximately 1 volt on VTVM or 5 uv on signal-strength meter.

2.6.6 Connect the VTVM to the discriminator output lead (TP-113).

2.6.7 Detune or back out the bottom or secondary slug of T105 until the VTVM shows a reading of .5 volt.

2.6.8 Peak top of primary slug of T105 to give maximum reading.

2.6.9 Retune bottom or secondary slug to center frequenc or zero reading on the VTVM.

2.6.10 When the visual alignment equipment is available, a sweep generator should be connected to the second limiter grid and the oscilloscope connected to TP-113 or the output connector. Primary and secondary should then be adjusted for maximum output with symmetry around a 21.4 mc center frequency.

2.7 I.F. Alignment

The characteristic of cascaded critical coupled amplifier stages is such as to make alignment difficult; however, the advantages of response stability, gain, and adjacent-channel selectivity make this type of coupling most desirable. Alignment has been kept as simple as possible by using transformers with almost identical characteristics. The primary and secondary Q's have been kept high and, therefore, the mutual coupling low for the required bandwidth. These factors suggest a rather simple alignment procedure with a minimum of equipment. The resonant frequency of the primary or secondary in the absence of the other (no coupling) is very nearly the proper tuning when the circuits are coupled.

If the primary circuit is detuned and the secondary adjusted to maximum output and then the primary tuned to maximum, the overall response will be approximately correct. The procedure is then as follows:

2.7.1 Remove oscillator tube to prevent mixing at a signal generator harmonic frequency.

2.7.2 Set receiver dial to 200 mcs.

2.7.3 Set signal generator to 21.4 mcs and connect to antenna terminals. If sufficient output is not obtained, connect to mixer grid.

2.7.4 Connect high-resistance voltmeter (Volt Ohmyst type) to second limiter grid return (test point TP-111). The signal strength meter may be used as an output indicator with equal accuracy.

2.7.5 Set generator to produce approximately 2 volts on VTVM or 5 uv on signal-strength meter.

2.7.6 If the I.F. amplifier is known to be considerably out of adjustment, it is desirable to peak T101, T102, T103, and T104 to provide adequate gain.

2.7.7 Detune primary by tuning the bottom slug of T104 counterclockwise against the stop.

2.7.8 Increase signal generator output to produce approximately 2 volts on VTVM or 5 uv on the signal-strength meter.

2.7.9 Adjust secondary (top) of T104 for maximum indication.

2.7.10 Adjust primary (bottom) of T104 for maximum indication, keeping signal generator adjusted for 2 volts output indication. DO NOT readjust secondary for maximum, as this will result in improper adjustment.

2.7.11 Repeat steps 2.7.9 and 2.7.10 for T103, T102, and T101. NOTE: It is not necessary that this sequence be followed, as any transformer may be adjusted without affecting the other.

The alignment may be checked by varying the signal generator frequency ±240 kc. The output voltage should be constant ±1 db over this range.

If a sweep generator and an oscilloscope are available, they may be used to check the response; however, the above procedure should first be performed and then the shaping checked or retouched as required in the light of the visual display. For this test, replace the signal generator with the sweep generator and the VTVM with the oscilloscope. Slight retouching of the transformers may give some improvement in response shape.

2.8 Check of Dial Stops

2.8.1 Loosen (4) screws on flexible coupling between dial and tuner.

2.8.2 Rotate knob clockwise to stop position.

2.8.3 Loosen set screws on dial.

2.8.4 Set dial to read "zero" and tighten set screws.

2.8.5 Rotate knob counterclockwise until dial returns to zero.

2.8.6 Set stop nut if necessary.

2.8.7 Rotate tuner shaft clockwise until tuner is stopped by its own mechanism.

2.8.8 Tighten screws on flexible coupling.

2.9 Local Oscillator Adjustment

The only adjustments to be made in the local oscillator are to make the tuning dial read properly. If the dial reading is correct, disregard this section. If a tube has been replaced and an error is noted, it may be corrected by adjustment of C116 (screwdriver adjustment adjacent to oscillator tube). This adjustment should be made with a signal generator of high accuracy with crystal check points spaced 2 to 10 mc and should be made at about 200 mcs. If component parts have been replaced or wiring disturbed, the dial may show an error at the high end (260 mcs.). This is correct by adjusting L105A (a short hairpin loop made of bus wire). Sufficient range may be obtained by adjusting the shape of this hairpin. The 200 mc point should then be rechecked since the adjustments are related.

The modification of the Clarke receiver was planned with a view to making the restoration to variable tuning as simple as possible. The bracket which mounts the coupling coil and the coaxial cable may be removed by taking out two screws, and unsoldering the 1 uuf coupling capacitor from the coupling coil. The free end of the coupling capacitor is then soldered back to the lug of L 105. The original 6J6 oscillator tube which was removed when the crystal oscillator was installed has been taped to its shield and to the top of the R.F. shield in the receiver. Insertion of this tube in the socket restores to operation the tunable oscillator. The three power leads to the crystal oscillator are then unsoldered and the crystal oscillator may be removed from the receiver. If it is not necessary to remove the crystal oscillator completely, variable tuning may be restored merely by changing the connection of the 1 uuf coupling capacitor, inserting the 6J6 tube, and disconnecting the red B+ lead to the crystal oscillator.

In some receivers after the crystal oscillator was installed, the VR150 regulator, V-112, ceased to function, since the three 5703 tubes draw about 8 ma more than the 6J6. When this conditon occured, R165 was adjusted until minimum current necessary to regulate was obtained. This adjustment was of the order of about 10%.

If it is necessary to change tubes, the leads of the replacement 5703 should be cut to .2 inches. A red dot on the socket shows which end the red dot on the tube should face. A seven pin socket is used in order to avoid bending the tube leads. Since there are only five leads on the tube, care should be observed in inserting the tube so that the leads go into the proper holes. Generally, little difficulty should be encountered as the supports and sockets are lined up to minimize error.

2.10 R.F. Amplifier Alignment

The band pass circuit between the R.F. amplifier and mixer need only be adjusted at the low end of the frequency range as the coupling and band pass are great enough at the high end to take care of all normal variations encountered. To adjust these circuits (C103 and C107) it is necessary only to tune in a signal at about 200 mcs (from a distant transmitter or loosely coupled signal generator) and adjust for maximum reading on the signal-strength meter. It will be noted that variation of C107 will affect the local oscillator frequency, and the dial should be adjusted to keep the signal in tune. The input circuit is sufficiently broad not to require adjustment. C105 should be adjusted only with visual equipment. The sweep generator should be connected to the antenna terminals and an oscilloscope to TP-117. The coupling should then be adjusted until a slightly overcoupled shape is observed.

2.11 Signal Strength Meter Calibration

This requires a signal generator with a 75 ohm output impedance and calibrated from 1 uv to 10 mv. Connect signal generator to antenna terminals and set to 215 mcs and 10 mv. across the output line. Tune receiver and set control in rear labeled "10 mv adjust" to read properly on signal-strength meter. The scale should be checked, but if considerable inaccuracy is noted, V104 should be replaced. If high accuracy is required, the calibration curve must be used.

3.0 Subcarrier Amplifier

3.1 General

The output from the Clarke FM receiver is fed into a subcarrier amplifier. Each amplifier has circuits for individually amplifying and separating four different subcarriers from the FM/FM composite telemetering signal coming from the receiver. In this station only the first three channels are used, the fourth is a spare.

As shown in Figure 17 the input lead supplies the composite signal through individual 500K gain controls, R501 through R504, to each of four cathode followers, V501 through V504. These tubes are mounted on the chassis immediately behind the front panel. The output circuits of these cathode followers connect through plug-in band pass filters to amplifier-cathode follower output tubes V502, V503, V505 and V506. These filters are mounted in individual cases and are plugged into four receptacles on the chassis. Heater voltage and 250 volts plate voltage are supplied by a separate regulated power supply. Connections are made through a 12 pin connector mounted at the rear of the chassis.

The meter M501 on the front panel can be connected by means of switch SW501, mounted immediately below it, to measure plate current to the various tubes.

In operation, the first cathode followers in the four channels serve principally to isolate the individual filter loads from the receiver output circuit and from each other. As the impedance of each filter is 510 ohms, four such filters in parallel would present a very low impedance load to the receiver output circuit, and would produce a very bad impedance mismatch. A further purpose in isolating the filter input circuits is to prevent the return of reflections from the filters to the receiver output circuit. The output signal from the filter drives the output tube. In the output tubes, which are 12AT7 twin triodes, the first triode is used as a linear amplifier to drive the second section which functions as a cathode follower output coupling means.

<u>NOTE:</u> Mounted above the gain control of each of the [illegible] channels is a white designation [illegible] frequency is to be written in pencil on this plate when the filter is installed or replaced.

4.0 Regulated [illegible] Supply

4.1 Theo[illegible] Operation

The [illegible]egulated power supply provides AC filament voltage and a regulated [illegible] plate voltage for the filter amplifier.

A [illegible]g choke input, two section filter provides good regulation and fil[illegible]. A 6AS7 variable resistance tube is used to regulate the ou[illegible]put voltage. Changes in load or supply voltage are compensated for [illegible] varying the transconductance of this tube to maintain constant ou[illegible]. The [illegible]SL7 tube (V703) using the voltage across V704 as a fixed [illegible]ence, operates to change the bias voltage on V7[illegible] in such a direc[illegible] as to [illegible]ose any change in output. Thus, if the line voltage falls, [illegible] bias [illegible] grids of V702 goes more positive. This increases the [illegible]ansconductance of V702, thus tending to maintain constant output current. [illegible] two triode sections of V702 are used in parallel, and a balance [illegible] R701 is provided to divide the current equally between the [illegible] sections. R701 is a screw driver adjustment located on the front [illegible]l. The panel meter in switch position 1 and 2 indicates separate[illegible] current through each triode section. With this switch in positio[illegible] the meter indicates total output current, and in position [illegible] the out[illegible] voltage. The rated power output of th[illegible] unit is 250 milliamperes. [illegible] screw driver adjustment R709 is available on the front panel for adjusting the output voltage to 250 volts.

The rated input power is 200 watts 115v 50-60 cycles. The 3Ag 5 ampere fuse is replaceable from the front panel.

A source of 6.3 volts AC heater current is also provided in the unit for use in external circuits.

4.2 Adjustment

After the power has been applied and the load with which the power supply is normally to be used is connected to P701, two adjustments are required. With meter switch S702 in position E, adjust "voltage adj." control R709 on front panel until meter reads 250 volts. With meter switch first in "Bal" position 1 and then position 2, adjust R701 until the meter reading is the same for both positions. These two adjustments must be repeated when any tubes are replaced.

4.3 Maintenance

4.3.1 No output AC or DC.

4.3.1.1 If the tubes including the pilot, do not light, replace fuse.

4.3.1.2 Check continuity of transformer primary and secondaries.

4.3.1.3 Check continuity of primary circuit from P701 through S701 and fuse F701.

4.3.1.4 Replace defective parts.

4.3.2 No DC output.

4.3.2.1 Replace tubes V701 (5R4GY) or V702 (6AS7).

4.3.2.2 Check continuity of power transformer secondary (T701).

4.3.2.3 Check continuity of chokes L701 and L702.

4.3.2.4 Check continuity of potentiometer R701 and resistors R711, R712, and R713.

4.3.3 Wrong DC output voltage.

4.3.3.1 If the tubes, transformer and chokes check satisfactorily, the circuit operation must be checked.

4.3.3.2 Using a vacuum tube voltmeter, measure the voltage across the 5651 voltage reference tube V704. It must measure between 82 and 89 volts.

4.3.3.3 If the voltage measures outside these limits replace the tube.

4.3.3.4 Check all capacitors for possible short circuits.

4.3.3.5 Using an accurate ohmmeter, measure the resistance value of each resistor on the terminal board. Any resistor which deviates from the indicated value by more than 20% should be replaced.

4.3.3.6 Variable resistor R709 on the front panel should also be checked for resistance value (10K).

5.0 Discriminator

5.1 Theory of Operation

The TDA-4 discriminator is capable of being tuned to any one of the subcarrier channels by means of a discriminator plug-in tuning unit. The functioning of the discriminator is the same for any subcarrier frequency employed.

The discriminator input stage employs a dual purpose vacuum tube with a triode section for signal amplification and diode section for rectification of a portion of the amplified input signal. This rectified signal is applied to a meter on the front panel for input signal level indication. The amplified signal from the triode section is fed to a clipper stage which limits the sine wave and feeds it to an Eccles Jordan trigger circuit having two stable limiting conditions. This stage functions as a signal limiter and wave shaper to provide a rectangular waveform.

The Eccles Jordan trigger output, after being differentiated, drives an amplifier stage which is biased to plate current cut-off. This amplifier performs the dual function of clipping the negative peaks while amplifying and inverting the phase of the positive peaks. The resulting negative signal pulses trigger a univibrator which has one stable limiting condition. The interval required for the univibrator to return to its stable condition after receiving a triggering pulse is controlled by a resistance capacitance network. Components in a plug-in tuning unit, in conjunction with controls on the front panel, determine the length of the unstable interval of the univibrator. The length of the unstable interval is, therefore, independent of the repetition rate of the driving signal pulse. The length of the stable period is dependent on the repetition rate of the signal pulse, since it is equal to the time of the unstable interval subtracted from the time interval between successive signal pulses. When the repetition rate of the signal pulses (equal to the input signal frequency) changes, the stable period of the univibrator is changed.

The two plates of the univibrator are coupled to the grids of a pushpull cathode follower. The rectangular signals from the cathodes of the cathode follower are fed through a resistance-capacitance low pass filter to the grids of another cathode follower.

The areas under the curves of the filtered positive and negative half cycles, applied to the grids of the cathode follower, vary relative to one another as a function of signal frequency. The output signal is taken from the cathodes of the second cathode follower. For a center frequency input signal, no output is developed because the area under the curve of the positive half cycle is equal to the area under the curve of the negative half cycle. For signals differing from center frequency, an output signal is developed whose polarity and magnitude are a function of the direction and amount of deviation of the input signal from the nominal center frequency. A zero center meter is located on the front panel and connected in series with one output lead to indicate output current and polarity.

Circuit constants and voltages are so chosen that, when the subcarrier signal is at center frequency, the voltage difference at the cathodes of the output cathode follower is essentially zero. Balance controls are provided to permit adjustment of the zero condition. Shifting of the subcarrier frequency above or below center frequency will thus cause a voltage difference at the cathodes to be indicated on the output meter as a shift in reading above or below the midscale zero reading.

Circuits are provided in the discriminator to protect the tubes and meters. These circuits function when the unit is first turned on, when an input signal outside the normal pass band is applied, and when the input signal is removed. The circuits performing the last two functions increase the stability of the discriminator by limiting the cathode current of the output stages to safe values.

5.2 Operational Check of Discriminator

5.2.1 General Functional Check

5.2.1.1 Connect discriminator in circuit shown in Figure 41 and tune the audio oscillator to the center frequency of the tuning unit in the discriminator. The total resistance of the meter and resistor must be 330 ohms. The meter should read 15 milliamperes each side of center.

5.2.1.2 Turn input control, R301, to zero.

5.2.1.3 Adjust output control R368 to 70.

5.2.1.4 Compensation polarity switch S304 should be in "OFF" position (center position).

5.2.1.5 Turn power switch, S301, "ON".

5.2.1.6 After two minutes warmup, check each position of the test meter switch, S302, to insure that the reading on the test meter, M303, are between .7 and .9.

5.2.1.7 Allow a 15 minute warmup period.

5.2.1.8 Turn input control, R301 to 100% and adjust audio oscillator output control to give midscale indication on the discriminator input meter, M301.

5.2.1.9 Press center test switch, S303, to momentary position and adjust output on M302 for zero (center scale) by means of the center adjust, R340. Then release switch, S303.

5.2.1.10 Rotate the fine balance control, R331, throughout its full range and set it to its approximate center position.

5.2.1.11 With center frequency applied to the discriminator from the oscillator, adjust the coarse balance control, R329, to give approximately zero output on the output meter, M302. Make final adjustment to zero with the fine control, R331.

5.2.1.12 Decrease slowly the frequency of the audio oscillatorto approximately -7 1/2% of center frequency and note the negative swing on the output meter, M302, which should vary in proportion to the input frequency change.

5.2.1.13 Increase the frequency of the audio oscillator slowly to approximately +7 1/2% of center frequency and note the positive swing on the output meter, M302, which should vary in proportion to the input frequency change.

5.2.1.14 Adjust the input frequency to +7 1/2% of center frequency. With total external load including meter, load resistor, and low pass filter (if any used) equal to 330 ohms, vary the output control R368 from 0 to 100 and note the logarithmic increase in current through the external meter.

5.2.1.15 Leave the output control R368 at 100 and note that the output current through the external meter is greater than +10 ma at +7 1/2%. Change the frequency to -7 1/2% and note that the external output current exceeds -10 ma at this point.

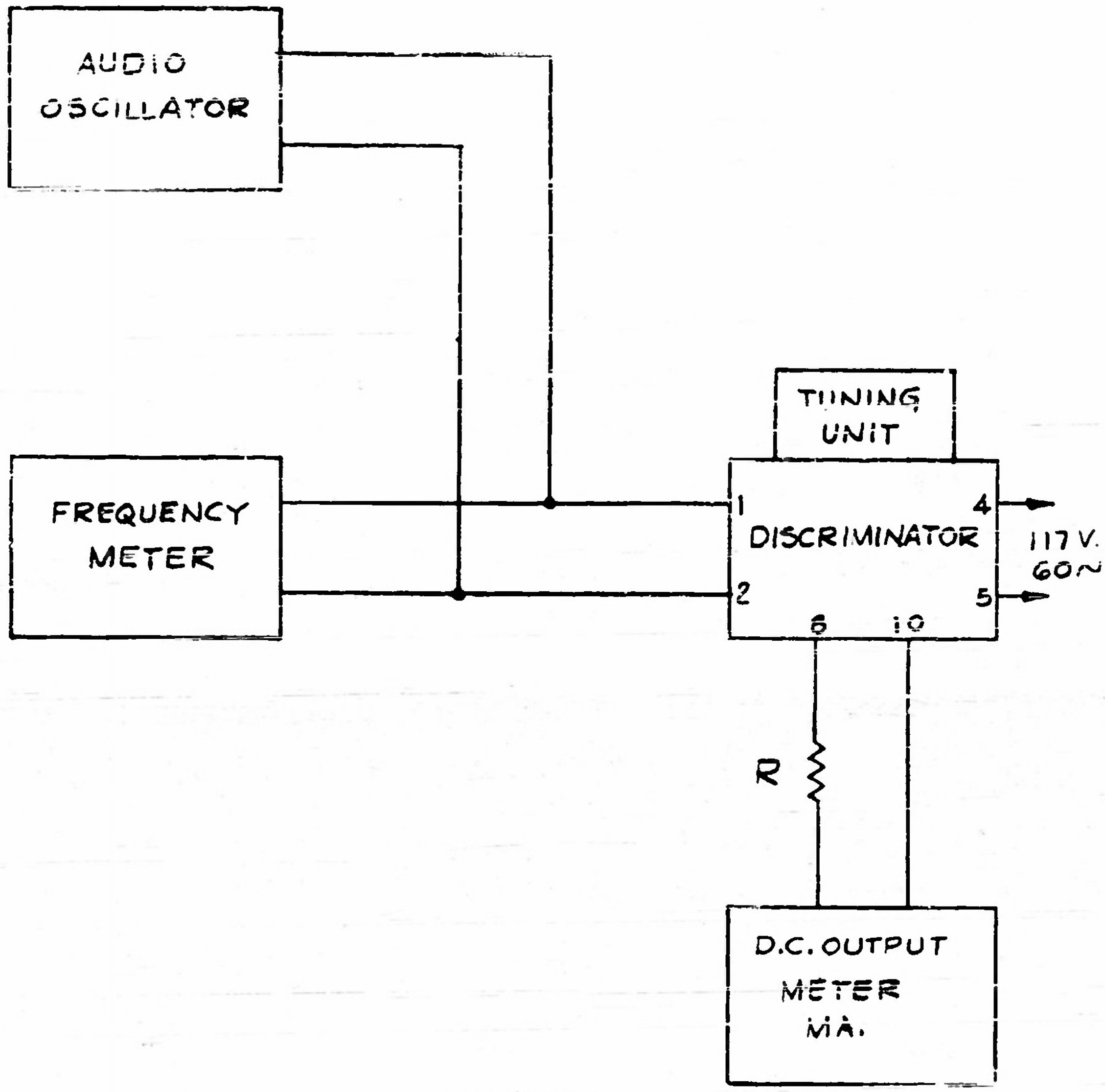
5.2.1.16 Again, with the output control R368 at 100, increase the frequency beyond the 7 1/2% and note the current through the external meter at which further increase in frequency will not change the output current. The output limiter should come into effect at approximately +15 ma. Repeat by decreasing the frequency, this limiter operating at -15 ma.

5.2.1.17 Check the standby stabilization circuit by observing the waveform on pin No. 5 of V303 when the input control R301 is turned to zero. It should be a square wave. The output meter M302 should indicate zero or center scale.

5.2.2 Linearity Check

5.2.2.1 Use the test setup as shown in Figure 41

5.2.2.2 Turn input control, R301, to 100% and adjust audio oscillator output control to give midscale indication on the discriminator input meter, M301.



1. THE OUTPUT METER SHOULD BE CAPABLE OF INDICATING 15 MA. EACH SIDE OF CENTER OR A POLARITY REVERSING SWITCH MUST BE INSERTED.
2. THE RESISTANCE (R) PLUS THE INTERNAL RESISTANCE OF THE METER SHOULD BE 330 OHMS.

DISCRIMINATOR TEST CIRCUIT

Figure - 41

5.2.2.3 Press center test switch, S303, to momentary position and adjust output on M302 for zero (center scale) by means of the center adjust, R340. Then release switch, S303.

5.2.2.4 Rotate the fine balance control, R331, through its full range and set it to its approximate center position.

5.2.2.5 With center frequency applied to the discriminator from the oscillator, adjust the coarse balance control, R329, to give approximately zero output on the output meter, M302. Make final adjustment to zero with the fine control, R331.

5.2.2.6 Set the output control to 100.

5.2.2.7 Adjust the input frequency to +7 1/2%, +2 1/2%, 0, -2 1/2%, -5%, -7 1/2% and record the output current on the external meter at each frequency.

5.2.2.8 Plot a curve of output current vs frequency. This curve should be linear within 0.5% of full scale reading.

5.2.3 Output Stability

5.2.3.1 Operating Stability

5.2.3.1.1 Use the test setup as shown in Figure 41.

5.2.3.1.2 Turn input control, R301, to 100% and adjust audio oscillator output control to give mid-scale indication on the discriminator input meter, M301.

5.2.3.1.3 Press center test switch, S303, to momentary position and adjust output on M302 for zero (center scale) by means of center adjust, R340. Then release switch, S303.

5.2.3.1.4 Rotate the fine balance control, R331, throughout its full range and set it to its approximate center position.

5.2.3.1.5 With center frequency applied to the discriminator from the oscillator, adjust the coarse balance control, R329, to give approximately zero output on the output meter, M302. Make final adjustment to zero with the fine control, R331.

5.2.3.1.6 Set the output control to 100.

5.2.3.1.7 Adjust the input frequency to center frequency.

5.2.3.1.8 Record the output current on the external meter after one-half hour, one hour, one and one-half hours, and two hours. Make sure that the center frequency is being applied when the reading is being taken.

5.2.3.1.9 The output current should not drift in excess of ±0.5% per hour.

5.2.3.2 Standby Stability

5.2.3.2.1 Use the test setup as shown in Figure 41.

5.2.3.2.2 Turn input control, R301, to 100% and adjust audio oscillator output control to give mid-scale indication on the discriminator input meter, M301.

5.2.3.2.3 Press center test switch, S303, to momentary position and adjust output on M302 for zero (center scale) by means of the center adjust, R340. Then release switch, S303.

5.2.3.2.4 Rotate the fine balance control, R331, throughout its full range and set it to its approximate center position.

5.2.3.2.5 With center frequency applied to the discriminator from the oscillator, adjust the coarse balance control, R329, to give approximately zero output on the output meter, M302. Make final adjustment to zero with the fine control, R331.

5.2.3.2.6 Set the output control to 100.

5.2.3.2.7 Adjust the input frequency to center frequency and record the output current on the external load meter.

5.2.3.2.8 Reduce the input control, R301, to zero.

5.2.3.2.9 After one-half hour, check the frequency to center frequency. Turn the input control to 100% and record the output current on the external meter.

5.2.3.2.10 Repeat steps (e) and (f) after one hour, one and one-half hours, and two hours.

5.2.3.2.11 The output current should not drift in excess of ±0.5% of bandwidth per hour.

5.2.3.3 Troubleshooting Procedure

5.2.3.3.1 General

Make a preliminary test by attempting to run through the operational check. The point in the procedure at which a peculiar characteristic is noted may indicate the circuit where the trouble exists. If this fails to disclose the source of the trouble, check individual circuits.

Connect the discriminator in a circuit as shown in Figure 41 and tune the audio oscillator to the center frequency of the tuning unit that is mounted in the discriminator.

Turn the input control, R301, 100% and the output control, R368, to 70.

Adjust the audio oscillator voltage to 5V rms.

Turn the compensation polarity switch, S304 to the "OFF" position.

Turn the power switch, S301, to the "ON" position. If the pilot light fails to light, check the fuze F301 and the indicator light I301.

Allow unit to warmup at least two minutes.

5.2.3.4 Discriminator voltages

This table indicates the DC voltages which can be expected at each pin of the tubes in the discriminator. The VTVM used to make these measurements must have a high impedance input such as the General Radio type 1800A. Voltages must be checked in the order given in the procedure in order to localize the trouble. The portion of discriminator circuit preceeding the points being tested must be functioning properly. The discriminator must be driven by the center frequency of the tuning unit being used, and be correctly balanced frequency.

NOTE

These voltages are measured positive with respect to the power supply or copper ground, and not chassis ground.

TABLE I

PIN NO.

Tube	1	2	3	4	5	6	7	8	9
V301	0	5.9	98	98	4.8 to -1.8	4.8 to -1.8	185	-	-
V302	70	28	28	98	98	110	18.5	28	98
V303	20.5	29	98	98	86	118	29	-	-
V304	8.7	14.5	98	98	86	97	14.5	-	-
V305	8.1	14.5	98	98	82	108	14.5	-	-
V306	310	82	98	98	98	310	85	97	98
V307	97	105	98	98	310	275	97	-	-
V308	97	105	98	98	310	280	97	-	-
V309	278	278	176	178	310	310	280	-	-
V310	105	112	98	98	275	158	112	-	-
V311	105	112	98	98	277	158	112	-	-
V312	- 4	0	98	98	0	- 4	280	-	-
V313	- 4	0	98	98	0	- 4	280	-	-
V314	150	-	-	0	150	-	0	-	-
V315	0.1	0.1	0.69	98	98	280	0.69	12	98
V316	0.12	1.25	98	98	290	150	1.25		

These voltages vary between the extremes shown as the input meter is varied from .2 to .8 ma.

5.2.3.5 Power Supply

Check each position of the test meter switch, S302 for a .7 to .9 ma reading on the test meter M303

If any of the readings are incorrect use an external VTVM to measure the DC voltage C325 (approximately 300 volts) and across V314 (approximately 150 volts).

If these voltages are incorrect, check the power supply components, including V312, V313, V314, R358, R359, R362, R367, C323, C324, C329, L301, and T301.

If these voltages measured correctly, check the test meter resistors associated with the position for which an incorrect reading was taken in step 1. These resistors include:

Position	Resistor
1	R360
2	R363
3	R362
4	R364
5	R361
6	R376

5.2.3.6 Tuning Unit

Replace the tuning unit and start a general functional check. If the discriminator now checks satisfactory the trouble may be assumed to exist in the tuning unit.

5.2.3.7 Pre-Amplifier Stage

Use an oscilloscope across pins 1 and 2 of the input connector J301. If the sine waveform is not received, check output of the audio oscillator and the resistance of the input level adjustment, R301.

On pin 1 of V301 the waveform should be as shown at A in Figure 20. If not check R302 and V301.

On pin of V316 the waveform should be similar but the top could be slightly flattened. If it is not, measure the DC voltage on pin 7 of V301. Check V301, R303, R305, R306, R383, and C303.

If no input is shown on the input meter, check V301, R304, C302, and M301.

5.2.3.8 Clipper-Driver Stage

The waveform on pin 5 of V316 should be a square wave. If not, measure the DC voltages for this tube and check the associated circuit components.

5.2.3.9 Eccles Jordan Limiter Stage

The waveform on pin 2 of V302 should be as shown at B in Figure 20. Measure the DC voltages for tube V302, and check associated circuit components.

5.2.3.10 Pulse Amplifier Stage

Check the waveform on pin 1 of V303 which should be shown at C in Figure 20. If not, check C307 and R315.

Also check the operation of relay K302 which should close contacts 2 and 3 when a square wave is seen on pin 2 of V302. Contacts 1 and 2 should be closed, and 4 and 5 should be closed with no input signal.

If the relay does not operate check the DC voltages on V315 and the associated components, C330, C331, R377, R378, R379, R380, and K302.

If the relay is operating correctly but there is no continuity between pins 2 and 3 in the operating position, clean contacts.

5.2.3.11 Univibrator Stage

Check the waveform on pin 5 of V304 which should be similar to E in Figure 20. If it is, vary the coarse balance control, R329, and the fine balance control, R331, and note the shift in half period K of the square wave G. If varying R329 and R331 causes no effect on the waveform, check the voltage divider network.

If the rectangular wave if not observed, remove V306 from the circuit and again check pin 5 of V304. If this produces the square wave, check V306 and replace if necessary.

If the square wave is not obtained, remove V304 and observe the waveform on pin 5 of V303. It should be similar to D. If it is not, measure the DC voltage on pin 5 of V303 and measure the resistance of R305, R316, R317, R324, R325, C308, C309 and L302.

If the negative pulses are similar to D in step 3, observe the same waveform (reduced in amplitude) on pin 13 of J303. If not seen check R325 and R326 and L302.

Proceed to pin 1 of V305 and note the negative pulse. If the pulse is not seen check V305.

If the pulse is observed on pin 1, observe pin 5 for an amplified positive pulse, similar to D but inverted. If this is not seen check the DC voltage on pin 5 of V305, which should read approximately 20 volts in this condition, and R319, R320, R323, R327 and C310.

After observing the pulse on pin 5 of V305, note the waveform on pin 1 of V304 which should also be a positive pulse, but of smaller amplitude. If this is not seen, check R319, R320, and the operation and contacts of relay K302 (note part 5.2.3.10)

If this waveform is satisfactory, check V304 and replace it in the tube socket if it checks good. Then check R322 and R324.

Adjust the coarse and fine balance controls R329 and R331 to give the maximum DC voltage on pin 5 of J303 and then the minimum voltage. These extreme voltages should be approximately 30 and 45 volts. If they are not correct, check R328, R330, and R331.

5.2.3.12 Push-Pull Cathode Follower Amplifiers

After a square wave has been obtained on pin 5 of V304, observe the waveform on pin 8 of V306, which also should be a square wave. If it is not check V306 and R337.

Observe the waveform on pin 3 of V306 which should be a square wave. If it is not check V306 and R338.

If the square wave is noted on both of these cathodes, it should then be possible to obtain equal DC voltages on pins 3 and 8 of V306 by variation of the coarse and fine balance controls R329 and R331.

5.2.3.13 Output Cathode Follower Amplifiers

After making the adjustment in 5.2.3.12 above, measure the DC voltages on pin 1 of V307 and 1 of V308 which should be equal and of the magnitude listed in Table 1. Vary the input frequency from -7 1/2% to +7 1/2% of center frequency and note that the DC voltage on pin 1 of V307 goes from positive to negative with respect to pin 1 of V308. If either of these tests fails, check V307, V308, R371, R372, R373, R374, S303, and S304.

Repeat the adjustment made in part 5.2.312 para. 9 above measure the DC voltage on pin 2 of V307 and 2 of V308 which should be equal and the same as indicated in Table 1. If this is obtained, then vary the input frequency and note that the DC voltage on pin 2 of V307 goes from positive to negative with respect to 2 on V308. If these two tests are satisfactory, check K301, M302, and R368.

5.2.3.14 Protective Circuit

If the tests in part 5.2.3.13 above fail, remove tubes V310 and V311 from the circuit and repeat set B. If satisfactory results are now obtained check V308, V307, R345, R346, R347, R348, R349, R351, R352, R353, R354, C320, C321, and C322.

If step (1) above fails, check V309, measure the DC voltage on pin 6 of V307 and V308 and check R339, R340, R341, R342, R343, R344, R346, R349, R350, R351, R356, R357 R375, C320, C321, and C322. If the DC voltage between chassis ground and the power supply is not correct as shown in Table 1, but the discriminator is functioning properly, check R356, R357, and C328.

6.0 Filters

6.1 Band pass

6.1.1 Theory of Operation

The band pass filters are used in the Filter Amplifier units to separate the individual subcarrier frequencies from the composite frequency modulated signal. The filters are made in two band widths, $\pm 7\frac{1}{2}\%$ and $\pm 15\%$ of center frequency. Attenuation within the adjacent filter bands is not less than 40 db.

6.1.2 Installation

The band-pass and high-pass filters are all packaged in similar cases, fitted with an octal socket. A flange on each end of the case contains a single twist type fastener having a slotted head. The filter is plugged onto an octal male receptacle mounted on the chassis of the amplifier filter, and a screw driver used to tighten the fasteners. Four filters are mounted side by side on the chassis.

6.1.3 Maintenance

Design of these filters is such that no maintenance is possible. Failures will not occur even with intermittent voice pulsed up to 100 volts peak amplitude. The filters will operate satisfactorily with continuous signal on noise levels up to 40 volts peak amplitude. Failure will occur only if the filters are used with voltages higher than their maximum ratings, and in this event they must be returned to the manufacturer for repair.

6.2 Low Pass Filter

6.2.1 Theory of Operation

The output signal from each discriminator is fed to its associated recording galvanometer through a low pass filter, Type TFL-2A. These filters are used for noise reduction, and attenuate at the discriminator output all frequencies above those necessary to convey the telemetering information. They greatly attenuate any fundamental or harmonics of the subcarrier which may get through the discriminator. These filters are available with 15 different cutoff frequencies from 20 cycles to 1050 cycles for use in conjunction with the ±7.5% band pass filters, and with additional five cutoff frequencies from 660 cycles to 2100 cycles, for use with ±15% band pass filters. Filters with a cutoff frequency of 218 cycles are supplied with this station. Figure 29 shows a representative performance curve for any of these filters.

6.2.2 Installation

TFL-2A low pass filter is housed in a metal case, with a 5-pin female receptacle on the bottom of the case. A flange on each end of the case contains a single twist type fastener with a slotted head. The filter is plugged onto a 5-pin male receptacle, mounted on the filter tray and secured by turning the fasteners with a screwdriver. Four filters can be mounted side by side on this tray.

6.2.3 Maintenance

Design of these filters is such that intermittent peaks of 100 volts, or continuous 40 volt signals, will not cause breakdown. If higher voltages are used and breakdown occurs, the filter must be returned to the manufacturer for repair.

7.0 Monitor Panel

7.1 Introduction

This assembly consists of an oscilloscope, a vacuum tube voltmeter and an associated switching system. Its purpose is to permit observations of signals from the receiver outputs and from the subcarrier amplifier outputs throughout that station.

7.2 Operation

The VTVM and Scope power switches should be on. Intensity, focus and positioning controls function to control the cathode ray beam in the usual manner, and normally require only initial adjustments. The vertical and horizontal gain controls may require readjustments from time to time to provide convenient size pattern. The VTVM voltage selector switch should be left on "AC" position for all following measurements.

7.3 Measurements

7.3.1 Receiver Outputs

To measure the outputs of any of the four receivers set the appropriate receiver switch (S901, S902, S903, or S904) in "RECVR" position, and set the VTVM selector switch (S905) to the corresponding position "A", "B", "C", or "D".

7.3.2 Subcarrier Amplifier Outputs

To monitor the outputs of any subcarrier amplifier set the VTVM selector switch to "CHAN" and index the channel selector switch (S906) to the desired channel. (In normal operation the receiver switches should be placed in "RECVR" position for these measurements so that the receiver outputs are applied to their respective subcarrier amplifiers.

These subcarrier outputs may be visually observed. A choice of 60 cps sinusoidal sweep or external (audio oscillator) sweep is available for this purpose.

7.3.3 Calibration

To test the subcarrier amplifiers and to calibrate the station a locally generated signal from the audio oscillator is applied to the subcarrier amps while the outputs are measured on the VTVM.

Index the function switch and the desired receiver switch to "CAL". (This injects the oscillator signal.) Placement of the VTVM selector switch to "A", "B", "C", or "D", according to the subcarrier amplifier employed, will allow measurement of this subcarrier amplifier input voltage. This should not exceed 1 volt in order to avoid overloading.) With the EPUT selector switch on "OSC" the oscillator frequency can be read on the EPUT frequency meter.

The outputs are observed as follows: Set the VTVM selector switch to "CHAN,"; then, as the channel selector switch is successively indexed to the desired positions, the subcarrier amp. outputs may be measured. (Shift the oscillator frequency as required for this test.)

7.3.4 Subcarrier Frequency Measurements

7.3.4.1 Direct Method

With the receivers and subcarrier amps. operating normally, the subcarrier frequencies generated at the telemeter transmitter are directly measureable with the EPUT meter. Set the function switch to "SUB.CAR.OUT" and position the channel selector switch to required channel.

7.3.4.2 Indirect Method

By the observance of oscilloscope Lissajous patterns the transmitted subcarrier frequencies can be indirectly measured. This method is especially advantageous where considerable carrier-frequency signal fading is experienced, or where the subcarrier waveforms are distorted, either of which condition could render the direct measurement by the EPUT meter unreliable.

With normal operation set the function switch to "OSC" and select the desired channel by means of the channel selector switch. The horizontal input switch should be placed on "EXT". These settings cause the sinusoidal oscillator output to be applied to the horizontal deflection plates, and the subcarrier signal to be applied to the vertical deflections plates. The EPUT meter reads the oscillator frequency, which can be varied as required.

7.4 Recording

After completion of all preliminary adjustments the four receiver switches should be placed in "RECVR" position, and the function switch in "RECORD". Check that all galvanometer interrupting switches of the oscillograph control assembly are in the center (open) position. With these settings preparedness to record will be indicated by the green record lamp. (Disturbance of any of these 5 switches on the monitor unit or of any of the 18 key switches on the oscillograph control unit will cause the "ready to record" lamp to extinguish.

7.5 Remote Control

Operation of the oscillograph control switch (S908) remotely control both recorder motors. The upward or manual (locking) position of the switch causes continuous operation of the recorders, whereas the downward position causes intermittent operation.

8.0 Audio Frequency Oscillator

8.1 Theory of Operation

The audio frequency oscillator is a wide range instrument having output frequencies from 200 to 200,000 cycles. This range is available in six bands 200-600, 600-2000, 2000-6000, 6000-20000, 20000-60000, and 60000-200,000 cycles. Output voltage is constant +1db up to 6000 cycles. Maximum output is 10 volts across rated 1000 ohm resistive load. Distortion is less than 1% up to 6000 cycles, with rated load.

The circuit consists of an oscillator, an amplifier, and a regulated power supply. The oscillator section is basically a resistance coupled amplifier over which both positive and negative feedback are applied. The positive feedback network is a variable frequency selective resistance capacitance mesh, and is used to control the frequency of oscillation. The negative feedback network which is used for stabilization includes a lamp filament also rises, increasing the negative feedback, thus tending to offset the rise in amplitude.

The output amplifier uses two tubes. Negative feedback is used in this circuit to minimize distortion to provide uniform frequency response and to obtain low impedance.

The power supply provides unregulated B voltage to the output amplifier. The conventional regulator circuit provides regulated B voltage to the two oscillator tubes.

8.2 Maintenance

8.2.1 Tubes

Tubes can be replaced by removing the 8 screws which hold the cover to the top and back of the oscillator and the 4 screws in the top. All corrective adjustments are made from the bottom of the chassis.

8.2.2 Trouble Shooting

8.2.2.1 Complete Failure

Complete failure may be caused by a defective fuse, defective power rectifier V5, or defective tubes, VI, V2, V3, or V6.

8.2.2.2 Erratic Operation

Erratic operation such as signal too high or too low may occur if V7 is defective or if R56 requires adjustment. R56 should be set so that the regulated +240 B voltage to the oscillator measures that voltage, using a high resistance DC voltmeter such as a Simpson Model 260. Failure of V4 will greatly reduce the output voltage. Failure of V8, the regulator tube, will cause the +240 regulated voltage to rise, with consequent increase in output signal and increased distortion. If either V1, V2, V3 or V4 are defective, increased distortion in the output signal may result. Excessive distortion may also be caused by leaking capacitors, or open bypass capacitors.

9.0 Frequency Meter

9.1 Theory of Operation

The frequency meter is a counter type instrument which counts and displays the number of events-per-unit-time (EPUT). The time interval of measurement is one second and the frequency range is from 20 to 100,000 cycles per second. The basic accuracy of the instrument is ±1 event.

The input circuit consists of two-stage amplifier and a trigger circuit. The differentiated output signal from this trigger is fed through the Input Gate to a series of five Berkeley Decimal Counting Units.

The time base which controls the Input Gate derives its accuracy from a 100,000 cycle crystal-controlled oscillator. This frequency is divided-down by a factor of 10^5 through a series of "locked in" one-shot multivibrators, resulting in an output of one pulse per second, The supply voltage for the time base is electronically regulated so that stability against line voltage variations is insured. A test switch is supplied for a direct check of proper operation. Pin jacks are provided inside the cabinet for making connections so that the instrument is self-checking for proper operation of each frequency divider stage. Screwdriver adjustments are provided for making corrections whenever they become necessary because of tube replacement, etc.

Control of the display time is accomplished by means of a system which opens and closes a Time Base Gate. As the gate can only be actuated by one second pulses from the dividing chain, the time between successive starts of counting is therefore an integral number of accurately controlled time units. Thus, although the readout time control is continuously adjustable, actual time between counts will be in multiples of one second over a range of one to five seconds.

The accuracy of each single measurement of events-per-unit-time depends upon the accuracy of the time base and upon the total number of events (or counts) received.

The time base accuracy is dependent upon the stability and accuracy of setting of the 100 kc. oscillator controlled by the crystal. The short term stability of the circuit used is better than 1 part in 10^5 under thermal conditions normal to indoor use. The frequency can be adjusted by the operator to any desired degree of accuracy within the limit of stability.

9.2 Test Information

The Operate-Test switch permits normal counting operation in position. In the Test position, a 100 kilocycle signal from the crystal oscillator in the time base is connected to the input of the frequency meter. With no input the count displayed should be either 99999 or 00000.

If the count is wrong, check the decimal counters, and the frequency dividers of the time base.

9.2.1 Set the sensitivity control at maximum.

9.2.2 Remove the units counter from the plug-in socket.

9.2.3 Replace with spare Model 705 counter.

9.2.4 After at least five minutes warmup, check the count. If the count is 99999 or 00000, the 705 counter was defective.

9.2.5 If the count is incorrect, exchange the tens counter (Model 700 second from right) with the fifth digit counter (Extreme left). If the count is now correct excepting for the highest digit, then the trouble lies in that decimal counter.

9.2.6 If the count is still incorrect, then exchange the tens counter with the fourth digit counter, and again check the count.

9.2.7 If the count is still incorrect, after exchanging all three higher digit counters with the second digit counter, check the time base frequency dividers.

9.3 Time Base Adjustment

There are seven twin diodes. The first, is the crystal oscillator, the second is the wave shaper, the third is the first frequency divider, the fourth is the second frequency divider, the fifth is the third frequency divider, etc. The time base channel is the middle vertical channel and the five frequency divider tube sockets are located to the left of their associated frequency adjustment potentiometers. The crystal oscillator is at the top, and frequency divider number five is at the bottom.

9.3.1 Remove the frequency meter from the cabinet and place it on a test bench.

9.3.2 After the warmup period, set Test-Operate switch on Test.

9.3.3 Set the sensitivity at maximum.

9.3.4 Adjust the time base frequency dividers.

9.3.5 Connect a 50 capacitor with short clip leads from pin 1 on V1345-2, the time base gate, to pin 6 on the second frequency divider tube V1131-4, the fourth tube from the bottom on the divider channel.

9.3.6 Adjust divider controls R1114-1 and R1114-2 until a count of 00100 is obtained.

9.3.7 Move the clip lead to pin 6 on the third frequency divider (third from the bottom).

9.3.8 Adjust R1114-3 until a count of 01000 is obtained.

9.3.9 Move the clip to pin 6 on the fourth divider and adjust R1114-5 for a count of 00000 or 99999.

9.3.10 Remove the capacitor and clip leads.

9.3.11 While watching the count, readjust each potentiometer to find the upper and lower limits of satisfactory operation.

9.3.12 Set the adjustment midway between these limits.

9.3.13 Reinstall the frequency meter in the cabinet.

SECTION V

PARTS LIST

1.0 The Y10980 Receiving Station consists of:

3	Y10984	Receiver Cabinet Assembly	(Cabinet A, B And C)
1	Y10983	Monitor Cabinet Assembly	(Cabinet D)
1	Y10982	Control Cabinet Assembly	(Cabinet E)
2	Type 5-114	Consolidated Oscillographs	
1	Y12705	Cable Assembly	(Cabinet A to B)
1	Y12706	Cable Assembly	(Cabinet B to C)
1	Y12707	Cable Assembly	(Cabinet C to D)
1	Y12708	Cable Assembly	(Cabinet D to E)
1	Y12709	Cable Assembly	(Cabinet to Oscillographs)

2.0 The Y10984 Receiver Cabinet Assembly contains:

1	555190	Regulated Power Supply
1	Y12381	Receiver Assembly
1	Y10992	Amplifier Assembly
1	555160-10	Filter Assembly Band Pass 7.35 KC.
1	555160-11	Filter Assembly Band Pass 10.5 KC.
1	555160-12	Filter Assembly Band Pass 14.5 KC.
3	555180	Discriminator Assemblies
1	555185-11	Tuning Unit Assembly 7.35 KC.
1	555185-12	Tuning Unit Assembly 10.5 KC.
1	555185-14	Tuning Unit Assembly 14.5 KC.
1	Y11236	Low Pass Filter Chassis Assembly
3	555170-9	Filter Assembly Low Pass 218 cps.
1	Y11156	Blower Assembly
1	Y12704	Cable Assembly

3.0 The Y10983 Monitor Cabinet Assembly contains:

1	555600	Monitor Panel
1	Y12381	Receiver Assembly
1	Y10992	Amplifier Chassis Assembly
1	555160-10	Filter Assembly Band Pass 7.35 KC.
1	555160-11	Filter Assembly Band Pass 10.5 KC.
1	555160-12	Filter Assembly Band Pass 14.5 KC.
3	Y11553	Discriminator Assemblies
1	555185-11	Tuning Unit Assembly 7.35 KC.
1	555185-12	Tuning Unit Assembly 10.5 KC.
1	555185-14	Tuning Unit Assembly 14.5 KC.
1	Y11236	Low Pass Filter Chassis Assembly
3	555170-9	Filter Assemblies Low Pass 218 cps.
1	Y11156	Blower Assembly
1	Y12702	Cable Assembly

4.0 Y10982 Control Cabinet Assembly contains:

1	Y11800	Audio Oscillator Assembly
1	Y11461	EFUT Meter Assembly
1	555220	Oscillograph Control Panel
1	Y11744	Master Power Panel
1	Y12703	Cable Assembly
2	Y14317	Blowers
2	10X10X1	Dustop Air Filters

5.0 Y-12381 RECEIVER ASSEMBLY

Circuit Designation	Description	Part Number	Manufacturer
C101	.001 uf, 500 v, ceramic disc.	CL1000	Radio Materials Co.
C102	500 uuf, ceramic	Style 331	Erie Resistor Corp.
C103	0.5-3 uuf, ceramic trimmer	7XA1482	Centralab Div. of Globe Union, Inc.
C104	1 uuf, ±10%, NPO, Ceramic	Style 301	Erie Resistor Corp.
C105	Same as C103		
C106	Same as C104		
C107	1-4 uuf, ceramic trimmer	7XA1482-003	Centralab Div. of Globe Union, Inc.
C108	10 uuf, ±5%, NPO, ceramic	Style A	Erie Resistor Corp.
C109	Same as C104		
C110	Same as C101		
C111	.005 uf, 500v, ceramic	CL 5000	Radio Materials Co.
C112	Same as C111		
C113	Same as C111		
C114	Same as C108		
C115	5 uuf, ±5%, NPO, ceramic	Style A	Erie Resistor Corp.
C116	Same as C107		
C117	Same as C115		
C118	Same as C101		
C119	Same as C101		
C120	Same as C101		
C121	Same as C101		

Circuit Designation	Description	Part Number	Manufacturer
C122	8 uuf, silver mica, built into T101 as integral part		
C123	40 uuf, silver mica, built into T101 as integral part		
C124	Same as C101		
C125	200 uuf, N750, ceramic	Style B	Erie Resistor Corp.
C126	Same as C102		
C127	Same as C111		
C128	Same as C102		
C129	Same as C102		
C130	Same as C111		
C131	Same as C122, built into T102 as intergral part		
C132	Same as C123, built into T102 as integral part		
C133	Same as C111		
C134	Same as C102		
C135	Same as C111		
C136	Same as C102		
C137	Same as C102		
C138	Same as C122, built into T103 as integral part		
C139	Same as C123, built into T103 as integral part		
C140	50 uuf, $\pm 5\%$, NPO	Style T	Erie Resistor Corp.
C141	50 uuf, $\pm 20\%$, N750K		Erie Resistor Corp.
C142	Same as C102		

Circuit Designation	Description	Part Number	Manufacturer
C143	Same as C102		
C144	Same as C102		
C145	Same as C122, built into T104 as integral part		
C146	Same as C123, built into T104 as integral part		
C147	Same as C111		
C148	Same as C140		
C149	33 uuf, ±5%	N220 CN	Electrical Reactance Corp.
C150	Same as C101		
C151	Same as C101		
C152	20 uuf, ±5%, NPO	CN796C	Electrical Reactance Corp.
C153	Same as C122, built into T105 as integral part		
C154	Same as C123, built into T105 as integral part		
C155	Same as C140		
C156	Same as C111		
C157	Same as C111		
C158	Same as C111		
C159	Same as C111		
C160	Same as C111		
C161	.01 uf, 500 v	D6-103	Centralab Div. of Globe Union, Inc.
C162	Same as C140		
C163	Same as C111		

Circuit Designation	Description	Part Number	Manufacturer
C164	Same as C161		
C165	.1 uf, 600 v	TVC6P1	Cornell-Dubilier Electric Corp.
C166	Same as C161		
C167	10 uf, 600v, paper	Type T6100	Cornell-Dubilier Electric Corp.
C168	Same as C167		
C169	Same as C140		
C170	Same as C111		
R101	120 ohms, ½ watt	Type E-B	Allen-Bradley Co.
R103	470 K, ½ watt	Type E-B	Allen-Bradley Co.
R104	Same as R103		
R105	150 K, ½ watt	Type E-B	Allen-Bradley Co.
R106	150 ohms, ½ watt	Type E-B	Allen-Bradley Co.
R107	Same as R106		
R108	3.3 K, ½ watt	Type E-B	Allen-Bradley Co.
R109	27K, ½ watt	Type E-B	Allen-Bradley Co.
R110	27 ohms, ½ watt	Type E-B	Allen-Bradley Co.
R111	220 ohms, ½ watt	Type E-B	Allen-Bradley Co.
R112	100 K, ½ watt	Type E-B	Allen-Bradley Co.
R113	1 K, ½ watt	Type E-B	Allen-Bradley Co.
R114	Same as R103		
R115	10 K, ½ watt	Type E-B	Allen-Bradley Co.
R116	51 ohms, ½ watt	Type E-B	Allen-Bradley Co.

Circuit Designation	Description	Part Number	Manufacturer
R117	4.7 K, ½ watt	Type G-B	Allen-Bradley Co.
R118	Same as R113		
R119	Same as R115		
R120	Same as R106		
R121	47 K, ½ watt	Type E-B	Allen-Bradley Co.
R122	Same as R113		
R123	1 M, ½ watt	Type E-B	Allen-Bradley Co.
R124	Same as R123		
R125	18 K, ½ watt	Type E-B	Allen-Bradley Co.
R126	10 K, ½ watt	Type E-B	Allen-Bradley Co.
R127	Same as R112		
R128	Same as R116		
R129	Same as R121		
R130	Same as R121		
R131	Same as R113		
R132	Same as R103		
R133	Same as R121		
R134	22 K, ½ watt	Type E-B	Allen-Bradley Co.
R135	Same as R109		
R136	33K, ½ watt	Type E-B	Allen-Bradley Co.
R137	Same as R113		
R138	13 K, ½ watt	Type E-B	Allen-Bradley Co.
R139	100 K, ±2%, ½ watt	Type E-B	Allen-Bradley Co.
R140	Same as R139		

Circuit Designation	Description	Part Number	Manufacturer
R141	Two 10 ohms, ½ watt, in parallel	Type E-B	Allen-Bradley Co.
R142	220 K, ½ watt	Type E-B	Allen-Bradley Co.
R143	Same as R142		
R144	Same as R112		
R145	1M, U Taper, Potentiometer	Type J	Allen-Bradley Co.
R146	Same as R103		
R147	Same as R142		
R148	130 K, ½ watt	Type E-B	Allen-Bradley Co.
R149	Same as R142		
R150	50 K, Linear	CU 5031	Ohmite Mfg. Co.
R151	Same as R121		
R152	Same as R134		
R153	Same as R150		
R154	Same as R108		
R155	Same as R136		
R156	Same as R108		
R157	10 K, 1 watt	Type G-B	Allen-Bradley Co.
R158	6.8 K, 1 watt	Type G-B	Allen-Bradley Co.
R159	Same as R123		
R160	500 K, A Taper, Potentiometer	Type J	Allen-Bradley Co.
R161	Same as R126		
R162	Same as R142		
R163	Same as R113		
R164	Same as R123		

Circuit Designation	Description	Part Number	Manufacturer
R165	2 K, 25 watts, Adjustable	#0377	Ohmite Mfg. Co.
R166	5 K, 25 watts	#0212	Ohmite Mfg. Co.

Connectors

Circuit Designation	Description	Part Number	Manufacturer
J101	Female, Coaxial	SO-239	American Phenolic Corp.
J102	Female, Coaxial, BNC Series	UG 290/U	Industrial Prod. Co.
J103	Same as J102		
J104	Same as J101		
P102	Male. coaxial, BNC Series	UG88/U	Industrial Prod. Co.
P103	Same as P102		
P601	Plug	16812-15	Cannon

Inductances

Circuit Designation	Description	Part Number	Manufacturer
L101	Spiral Inductuner	S-4	P.R.Mallory Co. Inc.
L101A	Inductance in Connecting Leads		
L102	Same as L101		
L102A	Inductance in Connecting Leads		
L103	Inductance in Connecting Leads		
L104	Same as L101		
L104A	Inductance in Connecting Leads		
L105	Same as L101		
L105A	Inductance in Connecting Leads		
L106	3.8 uh R.F. Choke	A-167-101	Clarke Instrument Corp.

Circuit Designation	Description	Part Number	Manufacturer
L107	2.5 uh, R.F. Choke	A-167-103	Clarke Instrument Corp.
L108	28 uh, R.F. Choke	A-167-102	Clarke Instrument Corp.
L109	Same as L108		
L110	10 h, Filter Choke	PH 1085	Chicago Transformer Co.
L111	Same as L110		

Meters

Circuit Designation	Description	Part Number	Manufacturer
M101	50 Microamperes Scale according to Clarke Instrument Drawing No. B-167-501	HM2	Marion Electrical Instrument Co.
M102	100-0-100 microamperes	HM2	Marion Electrical Instrument Co.

Speaker

Circuit Designation	Description	Part Number	Manufacturer
LS101	4" Permanent Magnet Type	Type 404S2	RCA

Transformers

Circuit Designation	Description	Part Number	Manufacturer
T101	I.F. Transformer	A-167-110	Clarke Instrument Corp.
T102	Same as T101		
T103	I.F. Transformer	A-167-109	Clarke Instrument Corp.
T104	Same as T103		
T105	Discriminator Transformer	B-167-524	Clarke Instrument Corp.
T106	Audio Output Transformer	A-167-108	Clarke Instrument Corp.
T107	Power Transformer	PHC-85	Chicago Transformer Co.

Circuit Designation	Description	Part Number	Manufacturer
	Hardware		
	Handle	1020	USECO
	Plug	106-73A	E.F.Johnson

NOTE: For receivers equipped with crystal oscillator units add the following parts.

C1	1000 uuf +100%-0% Silver Mica	906A	Centralab
C2	22 uuf ±10% Mica	463065	Standard
C3	100 uuf ±10% Mica	463097	Standard
C4	10 uuf ±10% Mica	463065	Standard
C5	1000 uuf +100%-0% Silver Mica	906A	Centralab
C6	500 uuf ±20% ceramic	CP2-A	Erie
C7	1000 uuf +100%-0% Silver Mica	906A	Centralab
R1	680 ±10% ½ W	RC20AE681K	Standard
R2	220 ±10% ½ W	RC20AE221K	Standard
R3	8.2 ±10% ½ W	RC20AE823K	Standard
R4	33 K ±10% ½W	RC20AE333K	Standard
R5	Same as R4		
R6	Same as R2		
L1	64.2-70.1 MC Coil	Y12119	Bendix
L2	1284-140.2 MC Coil	Y12120	Bendix
L3	250.8-280.4 MC Coil	Y12121	Bendix
L4	.74-.76 uh Coil	Y12127	Bendix

Circuit Designation	Description	Part Number	Manufacturer
L5	Coil Assembly Coupling	Y12798	Bendix
P1	Plug, R.F. Cable	VG-89V	Standard
J1	Connector Coaxial	31-003	Amphenol
V1	Vacuum Tube-Submin.	CK5703	Raytheon
V2	Same as V1		
V3	Same as V1		
Y	Crystal, Quartz $\pm$.01% (See table for frequency desired)	H17	James Knight

6.0 555150 SUBCARRIER AMPLIFIER

Circuit Designation	Description	Part Number	Manufacturer
C501, C502, C503, C504	Capacitor .05MF 400V	P488	Aerovox
C505, C506, C507, C508	Capacitor .5MF 200V	P288	Aerovox
C509, C510, C511, C512, C513, C514, C515, C516	Capacitor .05MF 400V	P488	Aerovox
	Handle, Panel	1020	USECO
	Knob, Pointer	4101-P	H.Davies Mold.
M501	Meter, Test	556456	Bendix
P501, P502 P503, P504	Plug, Octal	86-CP8	Amphenol
P505	Plug	16812-15	Cannon Elec.
R501, R502, R503, R504	Potentiometer 500K	AB	Ohmite
R505, R506 R507, R508	Resistor 3900-2W	RC42BF392K	Standard
R509, R510 R511, R512	Resistor 270-1W	RC30BF271K	Standard
R513, R514, R515, R516	Resistor 510-½	RC20BF511K	Standard
R517, R518, R519, R520	Resistor 100K - ½W	RC20BF104K	Standard
R521, R522 R523, R524	Resistor 1K - ½W	RC20BF102K	Standard
R525, R527 R540, R543	Resistor 2.2K - ½W	RC20BF222K	Standard
R526, R528 R541, R542	Resistor 18K - ½W	RC20BF183K	Standard

Circuit Designation	Description	Part Number	Manufacturer
R529, R530 R531, R532	Resistor 1 Meg. - ½W	RE20BF105K	Standard
R533, R538	Resistor .93 - ½W	60	Hycor
R534, R535 R536, R537	Resistor 15.67 - ½W	60	Hycor
R539	Resistor .40 - ½W	60	Hycor
	Tube Shield 1½" long	5-405	Amphenol

NOTE: All Resistor part Nos. with RC prefix are per JAN-R-11

Circuit Designation	Description	Part Number	Manufacturer
S501	Switch, two circuit 9 position	3229J	Mallory
V501, V504	Tube, Vacuum	5687	Standard
V502, V503 V505, V506	Tube, Vacuum	12AT7	Standard
XV501 thru XV506	Socket, 9 pin miniature	53F12621	Cinch

7.0 555180 DISCRIMINATOR

Circuit Designation	Description	Part Number	Manufacturer
	Cap, Switch	1343	H & H
C301	Capacitor, 5100 uuf 500V ±20%	RCM30D512J	El Menco
C302	Capacitor, .25 uf 400V	"Aerolite"P82	Aerovox
C303	Capacitor, .01 uf 500V ±20%	RCM30D103K	El Menco
C304	Capacitor, 5 uuf 500V±5%	CM15D050J	El Menco
C305	Capacitor, 51 uuf 500V ±5%	CM15D510J	El Menco
C306	Capacitor, .5uf 400V	"Aerolite"P82	Aerovox
C307	Capacitor, 10 uuf 500V ±5%	CM15D100J	El Menco
C308, C320, C322	Capacitor, .001 uf 300V ±20%	RCM20B102M	El Menco
C309, C311	Capacitor, .25 uf 200	"Aerolite"P82	Aerovox
C310	Capacitor, .5 uf 200V	"Aerolite"P82	Aerovox
C321	Capacitor, 430 uuf 300 ±5%	CM15D431J	El Menco
C323, C325	Capacitor, 8 uf 600V Electrolytic	TJU6080	Cornell-Dubilier
C324, C326, C327	Capacitor, 0.1 uf 400V	"Aerolite"P82	Aerovox
C328	Capacitor, 10 uf 450V Electrolytic	BR1045A	Cornell-Dubilier
C330	Capacitor, .05uf 400V	"Aerolite"P82	Aerovox
C331	Capacitor, .02 uf 200V	"Aerolite"P82	Aerovox
C332	Capacitor, .01 uf 500V ±10%	RC30D103M	El Menco
C312, C319, C329	Capacitor - See Note		

NOTE: 1. Capacitors C312 thru C319, and C329 are components of the tuning unit which is to be replaced in whole.

Circuit Designation	Description	Part Number	Manufacturer
L301	Choke, Filter: 15H	HS-307	Triad
L302	Choke: 3.4 MH	CH-1213	Bud Radio Inc.
J301	Connector, Jack: 15 contacts	S-315-AB	Jones
F301	Fuse, 3 amp 3 AG "Slo-Blo"	312003	Littlefuse
F301	Fuse Holder, Finger type	342001	Littlefuse
	Handle, Panel	1020	USECO
	Knob, Black with Pointer	4100P	Davies Mold
I301	Lamp, Pilot	#47	G.E.
M301	Meter, Input	556458	Bendix
M302	Meter, Output	556459	Bendix
M303	Meter, Test	556457	Bendix
R331	Potentiometer, 2K wirewound	43-2000	Clarostat
R329	Potentiometer, 15K wirewound	58-15000	Clarostat
R301	Potentiometer, 500K	Type A-B	Ohmite
R369	Potentiometer, Dual 50K each	PQ11-123 & M-11-123	IRC
R340	Potentiometer, 500 ohm wirewound	43-500	Clarostat
P301	Plug, Rack Type	16812-15	Cannon
	Plug, Index	106-73A	E.F.Johnson
K301	Relay, Thermal Delay 6.3V	6N060	Amperite
K302	Relay, Telephone Type	Type 6204	Advance
R302, R383	Resistor - 1 meg ±10% ½W	RC20BF105K	Standard
R303	Resistor - 1K ±10% ½W	RC20BF102K	Standard
R304, R307	Resistor - 4.7K ±10% ½W	RC20BF473K	Standard
R311, R314, R382, R305, R306, R356, R357	Resistor - 10K ±10% 1 W	RC20BF103K	Standard

Circuit Designation	Description	Part Number	Manufacturer
R365, R308, R315	Resistor - 100K ±10% ½W	RC20BF104K	Standard
R309, R310	Resistor - 390K ±10% ½W	RC20BF394K	Standard
R312	Resistor - 8.2K ±10% ½W	RC20BF822K	Standard
R313	Resistor - 150K ±10% ½W	RC20BF154K	Standard
R316	Resistor - 15K ±10% ½W	RC20BF153K	Standard
R317	Resistor - 33K ±10% ½W	RC20BF333K	Standard
R346, R351, R318	Resistor - 6.8K ±10% ½W	RC20BF682K	Standard
R319	Resistor - .5 meg ±1% ½W	70-L	Hycor
R320	Resistor - 75K ±1% ½W	70-L	Hycor
R321	Resistor - 2K ±1% ½W	70-L	Hycor
R322, R323, R337	Resistor - 25K ±1% ½W	70-L	Hycor
R324	Resistor - 40K ±1% ½W	70-L	Hycor
R325	Resistor - 10K ±1% ½W	70-L	Hycor
R326, R379	Resistor - 3.3K ±10% ½W	RC20BF332K	
R327, R338	Resistor - 50K ±1% ½W	70-L	Hycor
R328	Resistor - 100K ±1% ½W	70-L	Hycor
R330	Resistor - 30K ±1% ½W	70-L	Hycor
R339 R341	Resistor - 2.5K ±1% 7W	6B-13	Cinema Eng.
R342, R343	Resistor - 330 ohms ±10% ½W	RC20BF331K	Standard
R344, R350	Resistor - 220K ±10% ½W	RC20BF224K	Standard
R345, R354	Resistor - 39K ±10% ½W	RC20BF393K	Standard
R347, R348, R352, R353	Resistor - 4.7 ohms ±10% 1W	Type BTA	IRC
R349	Resistor - 470K ±10% ½W	RC20BF474K	Standard

Circuit Designation	Description	Part Number	Manufacturer
R358, R359	Resistor, 500 ohm ±10% 10W wirewound	"Brown Devil"	Ohmite
R355	Resistor - 2.74 ohms ±1%	Type 53	Hycor
R360	Resistor - 394K ±1% ½W	70-L	Hycor
R361, R376	Resistor - 1.08 ohms ±1% ½W	70-L	Hycor
R362	Resistor - .301 ohm ±1% ½W	70-L	Hycor
R363	Resistor - 188K ±1% ½W	70-L	Hycor
R364	Resistor - 3.03 ohms ±1%	70-L	Hycor
R366, R385	Resistor - 47K ±10% ½W	RC20BF473K	Standard
R367	Resistor - 4.5K ±10% 10W wirewound	"Brown Devil"	Ohmite
R368	Resistor - variable - 300 ohm, T-Pad Spec.	CIT-58	Clarostat
R370, R375	Resistor (Determined during test and calibration)	Replace in kind.	
R371, R372	Resistor - 68K ±10% ½W	RC20BF683K	Standard
R373, R374	Resistor - 2.2 meg ±10% ½W	RC20BF225K	Standard
R377	Resistor - 220K ±10% ½W	RC20BF224K	Standard
R378	Resistor - 1.5 meg ±10% ½W	RC20BF155K	Standard
R380	Resistor - 82K ±10% 2W	RC20BF823K	Standard
R384	Resistor - 100 ohms ±10% ½W	RC20BF101K	Standard
R386	Resistor - 2.2K ±10% ½W	RC20BF222K	Standard
R381 & R332 thru R336	Resistor - See note.		

NOTE: 1. Resistors R332 thru R336, and R381 are components of the tuning unit which is to be replaced in whole.

2. Resistor part numbers with RC prefix per JAN-R-11.

Circuit Designation	Description	Part Number	Manufacturer
	Shaftlock, Wrench type	1510	USECO
	Shaftlock, Hand type	1520	USECO
	Shield, Tube 2-¼ lg	754	Cinch
	Shield, Tube 1-3/4 lg	753	Cinch
	Shield, Tube 1-15/16 lg	952	Cinch
XI301	Socket, Panel Lamp (red)	81410-111	Dialco
XV301, XV302, XV304 XV305, XV307 thru XV314	Socket, Tube 7 Pin Miniature	9319	Cinch
XV302, SV306 XV315	Socket, Tube 9 Pin Miniature	53F12621	Cinch
XK301	Socket, Octal	77-MIP8	Amphenol
S301	Switch, Power	7500 K14	Cutler, Hammer
S302	Switch, Rotary 2 CIR. 6 POS.	3226J	Mallory
S303	Switch, Momentary	1340	Arrow Hart & Hedgeman
S304	Switch, Toggle DPDT CTR OFF 115V, 10A		Cutler-Hammer
T301	Transformer	6913	Triad
V301	Tube, Vacuum	6BF6	Standard
V303, V304, V305, V310, V311, V316	Tube, Vacuum	6AU6	Standard
V302, V306	Tube, Vacuum	12AU7	Standard
V307, V308, V309	Tube, Vacuum	6AQ5	Standard
V312, V313	Tube, Vacuum	6X4	Standard
V314	Tube, Gas Regulator	OA2	Standard
V315	Tube, Vacuum	12AT7	Standard

8.0 555190 REGULATED POWER SUPPLY

Circuit Designation	Description	Part Number	Manufacturer
C701, C702, C703	Capacitor, 6 uf 1000V	JAN CP70 BIEG605K	Standard
C704, C705	Capacitor, 0.1 uf 600V	CMIC-610	Tobe
L701	Choke, filter	555029	Bendix
L702	Choke, Filter	555031	Bendix
F701	Fuse, 5 amp.	312005-3AG	Littlefuse
XF701	Fuse, holder	342001	Littlefuse
	Handle, Panel	1020	USECO
	Knob, Instrument	S-308-64	Kurz-Kasch Co.
I701	Lamp, Pilot	47	Mazda
M701	Meter	Y09413	Bendix
	Plug	106-73A	E.F.Johnson Co.
P701	Plug	16812-15	Cannon
R701	Potentiometer, 175 ohm, 25W	0153	Ohmite
R702	Resistor, 25K 5W	5KT-25K	Sprague
R703	Resistor, 12.5K 5W	5KT-12.5K	Sprague
R704	Resistor, 240K ½W	RC20BF244	Standard
R705 R707	Resistor, 1 Meg. ½W	RC20BF105M	Standard
R706	Resistor, 68K 1W	RC30BF683M	Standard
R708	Resistor, 15K 2W	RC42BF153M	Standard
R709	Potentiometer, 10K	58-10,000WW	Clarostat
R710	Resistor, Precision 500K	60-500K	Hycor
R711, R712	Resistor, Precision 0.213 ohm	60-0.213	Hycor
R713	Resistor, Precision 0.1062 ohm	60-0.1062	Hycor
S701	Switch, Meter	173C	Mallory

Circuit Designation	Description	Part Number	Manufacturer
S702	Switch, Toggle	1330	H & H
	Shaftlock	1510	UESCO
XI701	Socket, Pilot Lamp	147-111	Gothard-Johnson
T701	Transformer, Power	5916	Altec Lansing
T702	Transformer, Filament	9305	Triad
	Tube, Shield, 7 pin medium 1 3/4 in.	7S3	Cinch
V701	Tube, Vacuum	5R4GY	Standard
V702	Tube, Vacuum	6AS7G	Standard
V703	Tube, Vacuum	6SL7GT	Standard
V704	Tube, Gas Regulator	5651	Standard

9.0 555600 MONITOR PANEL

Circuit Designation	Description	Part Number	Manufacturer
C901, C904	Capacitor, 0-1 uf400V	P82	Aerolite
C902, C905	Capacitor, .05 uf 600V	P82	Aerolite
C903, C906	Capacitor, 25 uf 25V		Aerovox
F901	Fuse, 3 amp, 3AG	312003	Littlefuse
XF 901	Fuse Holder, Finger Type 3 AG	342001	Littlefuse
	Handle, Panel	1020	U.S.Engr. Co.
	Knob, Instrument	4100	Davies Mold
	Knob, Instrument w/pointer	4100 P	Davies Mold
I 901	Lamp, Pilot Light	#47	G.E.
	Oscilloscope Assembly	90905	James Millen
XI 901	Pilot Assembly, Grn jewel	810-BF	Dial Co.
	Plug, Index	106-73A	E.F.Johnson
P901 thru P904	Plug, Rack Type	16812-15	Cannon Electric.
P905	Plug, AC	2717	G.E.
R906	Plug, Banana	108-75c	E.F.Johnson
R907, R908	Potentiometer, .5 Meg Type	CU-5041	Ohmite
J 905	A-B Receptacle, AC	2716	G.E.
R 901, R904	Resistor, 470 ohms ½W		Standard
R 902, R905	Resistor, 200K 1W		Standard
R 903, R906	Resistor, 33K 1W		Standard
	Shield, Tube Miniature	8661	Cinch
XV 901, XV902	Socket, 7 Pin miniature Tube	S010M	Cinch
S901 thru S904	Switch, Rotary	1405	Centralab
S905	Switch, Rotary - 2 gang 1 Circuit, 1 gang	1411	Centralab

Circuit Designation	Description	Part Number	Manufacturer
S906	Switch, Rotary 1 gang 1 circuit	32117J	Mallory
S907	Switch, Rotary 3 gang 2 circuit/gang	1425	Centralab
S908	Switch, Telephone Type	1044B	Cinema Engr.
	Vacuum Tube Voltmeter	Model 62	Measurement Corp.
V901, V902	Tube, Vacuum	6AU6	Standard
Scope	Tube, Rectifier	2X2A	Standard
VTVM	Tube, Rectifier	5W4	Standard
Scope	Tube, Rectifier	5W3	Standard
VTVM	Tube, Vacuum	6C5	Standard
VRVM	Tube, Vacuum	6H6	Standard
Scope	Tube, Cathode-Ray	5UP1	Standard

10.0 Y11461 EPUT METER

Circuit Designation	Description	Part Number	Manufacturer
C1201	Capacitor - 610 uuf ±10% 300 V		
	Handle, Panel	1020	USECO
	Plug, Index	106-73A	E.F.Johnson
P1201	Plug, Rack Type RTC 12-34-3	16812-15	Cannon
R1206	Potentiometer, 50K Carbon	Type AB	Ohmite
P1202	Prod, Test - Phone tip	94	Bud Radio Inc.
R1201	Resistor, 2.4 meg ±10% ½W	RC20BF245K	Standard
R1202, R1203	Resistor, 1.5 meg ±10% ½W	RC20BF155K	Standard
R1204	Resistor, 330K±10% ½W	RC20BF334K	Standard
R1205	Resistor, 560K +10% ½W	RC20BF564K	Standard
	Shield, Tube - 1-15/16 lg	952	Cinch
XV1201	Socket, Tube 9 Pin Miniature	53F12621	Cinch
V1131-1, V1131-2 V1344-1 thru V1344-5 V1346, V1 thru V4 V1131-4 thru V1131-7, V1201	Tube, Vacuum - Miniature	12AU7	Standard
V1136	Tube, Vacuum	12BH7	Standard
V101	Tube, Rectifier	5U4G	Standard
V102	Tube Vacuum	6Y6	Standard
V103, V1341	Tube Vacuum	6AU6	Standard
V104	Tube, Gas Regulator	OB2	Standard
V1345-1, V1345-2	Tube, Vacuum	6AS6	Standard

NOTE: 1. For parts not listed see schematic.
2. Resistor part mumbers with RC prefix per JAN-R-11

11.0 Y11800 AUDIO OSCILLATOR

Circuit Designation	Description	Part Number	Manufacturer
C1	Tuning Capacitor and Drive Assembly	I-100	Hewlett-Packard
C2, C4	Capacitor: fixed, sliver mica, 330 uuf; 500vdcw; Electrical value adjusted at factory		
C3, C5	Capacitor, variable, air, 50 uuf	J-55L	Sarkes Tarzian
C6	Capacitor: Electrical value adjusted at factory		
C7	Capacitor: fixed, paper, .5 uf, -10% +20% 600 vdcw	684	Aerovox
C8 abc	Capacitor: fixed, electrolytic, 10, 10, 10 uf, 400 vdcw	FPT-389	Mallory
C9	Capacitor: fixed, paper, 2000 uuf, -25% +50% 600 vdcw	684	Aerovox
C10, C13, C15, C16	Capacitor: fixed, electrolytic 40 uf, 450 vdcw	FPS-146	Mallory
C11	Capacitor: fixed, electrolytic 20 uf, 450 vdcw	FPS-144	Mallory
C12	Capacitor: fixed, paper, .1 uf, ±10% 600 vdcw	P688	Aerovox
C14	Capaciator: fixed, paper 4 uf, ±10% 600 vdcw		Girard Hopkins
C17	Capacitor: fixed, paper .05 uf, -10% +30% 600 vdcw	P688	Aerovox
R1-R6, R13-R18	Part of Range Switch Assembly		
R7-R12	These circuit references not assigned.		
R19-R21	These circuit references not assigned.		
R22	Resistor: variable, composition 20,000 ohms, linear taper	33-010-725	Centralab

Circuit Designation	Description	Part Number	Manufacturer
R23	Resistor: variable, composition 10,000 ohms, linear taper	JLU 1031	Allen-Bradley Co.
R24	Resistor: variable, compositon 2000 ohms; linear taper	37	Clarostat
R25	Resistor: variable. wirewound 1000 ohms; linear taper	21-010-355	Centralab
R26	Resistor: variable, 200 ohms		
R27	Resistor: variable, wirewound 100 ohms; linear taper	21-010-354	Centralab
R28	Resistor: variable, wirewound 1000 ohms; linear taper	27-010-355	Centralab
R29	Resistor: fixed, wirewound 1500 ohms; $\pm$10% 1W	BW	InternationalRes.
R30	Lamps: 6W 120V		G.E.Supply Corp.
R31, R33, R40, R41, R42, R43	Resistor: fixed, composition 56,000 ohms; $\pm$10% 1W	GB 5631	Allen-Bradley
R32	Resistor: fixed, composition, 100,000 ohms; $\pm$10% 2W	HB 1041	Allen-Bradley
R34, R36	Resistor: fixed, composition 270 ohms; $\pm$10% 1W	GB 2711	Allen-Bradley
R35, R44 R52	Resistor: fixed, composition 560,000 ohms; $\pm$10% 1W	GB 5641	Allen-Bradley
R37	Resistor: fixed, wirewound 5000 ohms; $\pm$10% 20W	A 2580	Sprague
R38	Resistor: variable, composi- tion, 25,000 ohms; linear taper	JU 2531	Allen-Bradley
R39, R47	Resistor: fixed, composition, 10,000 ohms; $\pm$10% 1W	GB 1031	Allen-Bradley
R45	Resistor: fixed, composition, 560 ohms; $\pm$10% 1W	GB 5611	Allen-Bradley
R46	Resistor: fixed, wirewound, 5000 ohms; $\pm$10% 10W	1-3/4E	Lectrohm, Inc.

Circuit Designation	Description	Part Number	Manufacturer
R48	Resistor: variable, wire-wound, 50 ohms: linear taper	Z1-010-067	Centralab
R49, R50	Resistor: fixed, composition 100,000 ohms; ±10% 1W	GB 1041	Allen-Bradley
R51	Resistor: fixed, composition 10,000 ohms; ±10% 2W	HB 1031	Allen-Bradley
R53	Resistor: fixed, composition 33,000 ohms; ±10% 1W	GB-3331	Allen-Bradley
R54	Resistor: variable, composition,25,000 ohms linear taper	BAI-010-1990	Centralab
R55	Resistor: fixed, composition 47,000 ohms; ±10% 1W	GB 4731	Allen-Bradley
R56	Resistor: fixed, composition 270,000 ohms; ±10% 1W	GB 2741	Allen-Bradley
	Binding Post:	312-3	Hewlett-Packard
	Dial Indicator:	I-100N	Hewlett-Packard
	Escutcheon:	G-99A	Hewlett-Packard
F1	Fuse, 1A,	3 AG	Bussman Mfg.Co.
	Fuseholder:	342001	Littlefuse,Inc.
	Indicator Lamp Assembly	807BS	Singal Indicator Co.
	Knob: 1-5/8" diam.	37-12	Hewlett-Packard
	Knob: 1-1/2" diam.	37-11	Hewlett-Packard
	Knob: 2" diam.	37-13	Hewlett-Packard
I1	Lamp, Mazda	47	G.E.Supply Co.
	Lampholder	659-1	Leecraft MFG.
	Handle, Panel	1020	USECO

Circuit Designation	Description	Part Number	Manufacturer
P1301	Plug	16812-15	Cannon
L1	Reactor: 6H at 125 ma. 240 ohms	911-12	Hewlett-Packard
S1, R1-R6 R13-R18	Range Switch Assembly		Hewlett-Packard
S2	Rotary Switch	81715	Arrow, Hart and Hegeman
T1	Power Transformer	910-55	Hewlett-Packard
V1, V3	Tube: Vacuum	6SJ7	Standard
V2	Tube:	6AG7	Standard
V4	Tube:	6V6	Standard
V5	Tube:	5Y3GT	Standard
V6	Tube:	6L6G	Standard
V7	Tube:	6SQ7GT	Standard
V8	Tube: Gas Regulator	VR150	Standard

12.0 Y11236 LOW PASS FILTER CHASSIS ASSEMBLY

Circuit Designation	Description	Part Number	Manufacturer
P101	Socket Octal	78-S8	Amphenol
P102	Same as P101		
P103	Same as P101		
P104	Same as P101		
P105	Plug	16812-15	Cannon Elec.
	Plug	106-73A	E.F.Johnson
S101	Switch-DPDT	20510	Arrow H&H
S102	Same as S101		
S103	Same as S101		
S104	Same as S101		

13.0 555220 OSCILLOGRAPH CONTROL PANEL

Circuit Designation	Description	Part Number	Manufacturer
J801 thru J836	Jack	1399B	Cinema Engr.
S801 thru S838	Key, Lever	1044H	Cinema Engr.
P801 thru P806	Plug, Rack Type	16812-15	Cannon Elec.
S801 thru S818	Switch, Toggle DPDT Bat Handle	20510	Arrow H&H
R801 thru R818	T-Pad - 330 Ohms	CIT-58	Clarostat
	Handle, Panel	1020	USECO
	Plug, Index	106-73A	E.F.Johnson
	Shaftlock, Hand Type	1520	USECO

14.0 Y11156 BLOWER PANEL

Circuit Designation	Description	Part Number	Manufacturer
B201	Blower	3B08	Ilg Elec.
F201	Fuse, 5 amp	3AG	Littlefuse
I201	Light Pilot 115V	16S6	Mazda
J201	Receptacle	1913	Arrow H&H
P201	Plug	16812-15	Cannon Elec.
S201	Breaker, Circuit	0411	Heineman Elec.
XF201	Holders, Fuse	342001	Littlefuse
XI201	Socket, Lamp	147-1201	Johnson-Gothard
	Filter, Fiberglass	10X10X1	Owens-Corning
	Handle, Panel	1020	USECO

15.0 Y11744 MASTER POWER PANEL

Circuit Designation	Description	Part Number	Manufacturer
I401	Light, Pilot 115V	6S6	Mazda
I402	Same as I401		
J401	Outlet, Duplex	1913	Arrow H&H
S401	Breaker, Circuit 30 amp.	0411	Heinemann Elec.
S402	Breaker, Circuit 15 amp.	0411	Heinemann Elec.
XI401	Socket, Lamp	147-1201	Johnson-Gothard
XI402	Same as XI401		

PART II

MOBILE TELEMETERING RECEIVING TRAILER

SECTION I

GENERAL DESCRIPTION

1.0 Electrical Power System

1.1 External Power Source

Since these telemetering trailers are often required to operate at remote locations where there is no source of commercial power, four portable 12.5 KVA gasoline engine- generator units, type PE 95K are provided to supply power to the three trailers. Four 100 ft., 2-conductor power cables are fitted at one end with lugs to connect to the generators and at the other with a Crouse-Hinds Arktite plug which mates a receptacle mounted on the right side of each trailer.

1.2 Internal Power Connections

From the trailer receptacle, the power is fed to a 100 amp. enclosed circuit breaker where it is distributed to a 28 volt power supply, a Stabiline voltage regulator and bank of three switches which supply the lights, the outlet strips and the air-conditioning system. The outlet strips are fed directly from the switch bank where as the lights and the air-conditioning system have individual switches to facilitate combined or independent operation.

1.3 Power Supply - 28 V.D.C.

The 10 amp 28 volt DC power supply is a selenium type rectifier operating from a 110/28 volt transformer, and supplies two antenna position control panels. (APCP)

1.4 Stabiline Voltage Regulator

The Stabiline Automatic Voltage Regulator, Type EM 4106, 6.0 KVA single phase, which supplies a regulated voltage to the two trailer telemeter stations and consists of a bridge and thyratron circuit controlling a motor-operated powerstat variable transformer. This electronically controlled regulator delivers a constant output voltage independent of line voltage, load current and load power factor, considerations very important to the operational stability of the telemetering stations. The output voltage is a faithful and distortionless reproduction of the applied waveform. Although the regulator provides high speed correction, if the line voltage constantly varies a small amount due to transients, possibly caused by heavy starting loads, the regulator will not be able to smooth out these variations.

1.5 Air-Conditioning System

The air-conditioning system consists of two CARRIER model 51S3 refrigerated air-conditioners and one trailer exhaust fan. Due to the excessive amount of heat dissipated by the two telemetering stations into the confined space of the trailer, it was necessary to install two air-conditioning units to maintain a suitable working temperature for the equipment and the operating personnel. The second air-conditioner is energized from a separate motor-generator unit through a separate power cable and trailer, receptacle circuit in order to prevent overloading of the E-G set supplying power to the telemetering stations. The air-conditioners operate on 220 volts and a 110/220 volt step-up transformer is used with each unit.

2.0 Antenna System

2.1 General

The trailer antenna system can be classified into two categories: The receiving antenna system and the antenna position control system. The receiving antenna system consists of two antenna masts, two receiving antennas, the antenna coax lead-ins and two antenna couplers. The antenna position-control system consists of the position-control transmitters and drive motors, and two antenna position-control panels on which are mounted the position-control switches and indicators.

2.2 Receiving Antenna System

2.2.1 Antenna Masts

Two masts are located on the top of each trailer positioned diagonally across from each other to provide maximum spacing between the two, each of which is for one T/M station. The two masts are so hinged at the base that they can be folded down and attached to the top of the trailer. When extended in the up position, the antenna projects 20 ft. above the top level of the trailer.

2.2.2 Receiving Antenna Assembly Y-15477

The receiving antenna is a stacked antenna consisting of two 3 element parasitic arrays, vertically polarized with folded dipoles as the radiators, a reflector and director. This type provides high gain and a high front-to-back ratio. The two arrays are spaced a half wavelength apart and are fed 90 degrees out of phase to obtain the desired radiation pattern. The two arrays are fed through ballon transformers, for the purpose of balancing the antenna feed to ground thus reducing the standing wave ratio.

2.2.3 Coax Lead-in

Each of the two arrays of one antenna feeds separate RG-11/U coaxial cables which differ in length by a quarter-wavelength at the operating frequency as measured on a slotted line, thus obtaining the 90 degrees phasing in the feed to the antenna coupler.

2.2.4 Antenna Couplers - Y-15478

Two antenna couplers are used, one for each station. It is a quadruplexing balanced-bridge type employing three "magic T" coaxial rings each of which consist of eight specific lengths of coaxial cable and two RLC circuits enclosed in a metal housing.

2.3 Antenna Position-Control System

2.3.1 Antenna Position-Control Panel Y-16317

The antenna position-control panel is mounted at the top of cabinet "C" in each station and consists of a position - indicator which indicates the azimuth and elevation position of the antenna, and azimuth and elevation switch control which affords movement of the antenna to the desired position, and an elevation and azimuth calibration adjust for the purpose of indicator position correction.

The position indicator is a dual indicating type meter, one indicator for azimuth position from 0 to ±90 degrees and the other for elevation from 0 to +90 degrees. It is possible to adjust the antenna mechanically in order that 180 degrees can scanned.

2.3.2 Position-Control Motors and Gearing

Each antenna mast is equipped with two 28 volt drive motors, one to move the antenna in azimuth and the other, in elevation. Each motor has two field windings such that the direction of motor rotation can be selected by energizing the proper winding. Micro-switches enclosed in the motor unit limit the amount of travel in both direction such that by the proper gearing the antenna is limited to 180 degrees azimuth rotation and 90 degrees in elevation.

The position-control drive motors are mounted in a housing at the base of the mast and are geared to the gear-housing at the top of the mast by drive-shafts; the elevation control is brought through the center of the main mast and the azimuth control through a shaft alongside the main mast.

2.3.3 Position Control Switches

The position-control switches, mounted on the antenna control panel are 4PDT, momentary ON-OFF-ON switches with the normal position being off. Thus depending on which switch is energized and in which position, the antenna will move either right, left, up or down.

2.3.4 Position-Control Transmitters

The position-control transmitters are mounted in the motor housing at the base of the antenna mast and consist of two 100 ohm potentiometers which are spring loaded and geared to the antenna drive motors by a phosphor-bronze cable such that the antenna movement is translated into a resistance change which results in a change of meter indication.

3.0 Inter and Intra Trailer Wiring

3.1 Inter-Trailer Wiring

A junction box is located on the right side of the trailer in which all electrical circuits external to the T/M receiving stations are located. In addition to containing junction points for the inter-com, and timing circuits cables between trailers, this box also serves as a junction box for the antenna-position control system.

The cable connectors are wired for an inter-com circuit and three timing circuits. The inter-com circuit feeds two field phones and an amplifier in each trailer for the purpose of communicating between trailers and three timing circuits for the purpose of synchronizing the oscillograph records of all the stations. Each trailer is equipped with two parallel plugs so that irrespective of which trailer may be located between the other two, a cable may be run from that trailer to the other two.

3.2 Time Base

The three timing circuits include time base, range time, and zero time signals. The time base signal originates in the telemetering ground station and is a 1 cps pulse signal which is fed to a switch in the trailer junction box. This switch is a DPDT, ON-OFF-ON, switch which selects the 1 cps signal which is to be used in the system as a common time base.

3.3 Zero Time

The zero time signal is a pulse signal which originates from a photo-electric cell unit which has to be set up external to the trailer exposed to ground zero so that at the time of the flash a pulse will be fed to the system and hence recorded on the telemetering record synchronizing all telemetering records.

3.4 Range Time

The range time signal is a signal originating external to the telemetering system for the purpose of synchronizing the telemetering records with any other records which may be taken simultaneously using the same range time signal source.

SECTION II

PREPARATION TO OPERATION

1.0 Electrical Power System - Y-16331

1.1 Trailer Location

The desired location of one trailer with respect to the others is such that the antennae are the maximum distance apart with respect to the signal source which is a pattern such that the receiving trailers are in a line (See Figure 43) with the signal source being in a direction, broadside from the trailer. The desired location of the power units, PE-95K's, would be at a maximum distance from the trailers and in the opposite direction from the signal source in order to reduce the possibility of interference from the ignition system.

1.2 Power Connections

The two conductor, four gage, rubber covered cable provided with each trailer is connected to the 110V output terminals of a PE95K power unit and the other end with the Crouse-Hinds 3-pin plug, is connected to the proper receptacle on the side of the trailer. Each power unit will then provide power to one trailer for its operation. (See Figure 43).

The smaller power cable provided with each trailer has a 2-pin Crouse-Hinds plug and that cable is connected to the proper receptacle on the side of the trailer and the three cables are connected in parallel to the fourth power unit provided for this purpose. This power unit will then provide power for the operation of the second air-conditioner unit in each trailer.

Each trailer and power unit chassis must be grounded to earth to prevent the buildup of a charge between the trailer and earth. A precaution which must be taken prior to connecting the ground to each trailer is to measure the voltage between the trailer chassis and ground with all power units operating. A reading of 110 volts indicates that the output connections on the respective power unit should be reversed.

2.0 T/M Trailer Antenna System

2.1 Receiving Antenna Installation

2.1.1 Antenna Locations

Each trailer is equipped with two folding antenna masts on each of which is mounted one antenna. Below is a table listing the antenna location, the antenna number, the coax pair number, the corresponding receivers which it feeds and the channels which the combination covers:

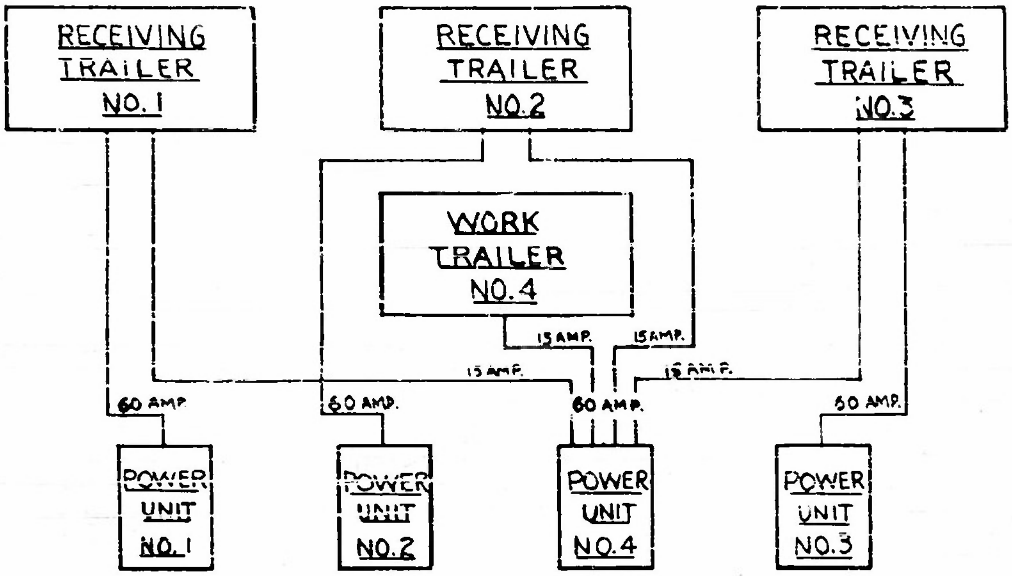


Figure 42 - Block Diagram, Trailer Power Distribution

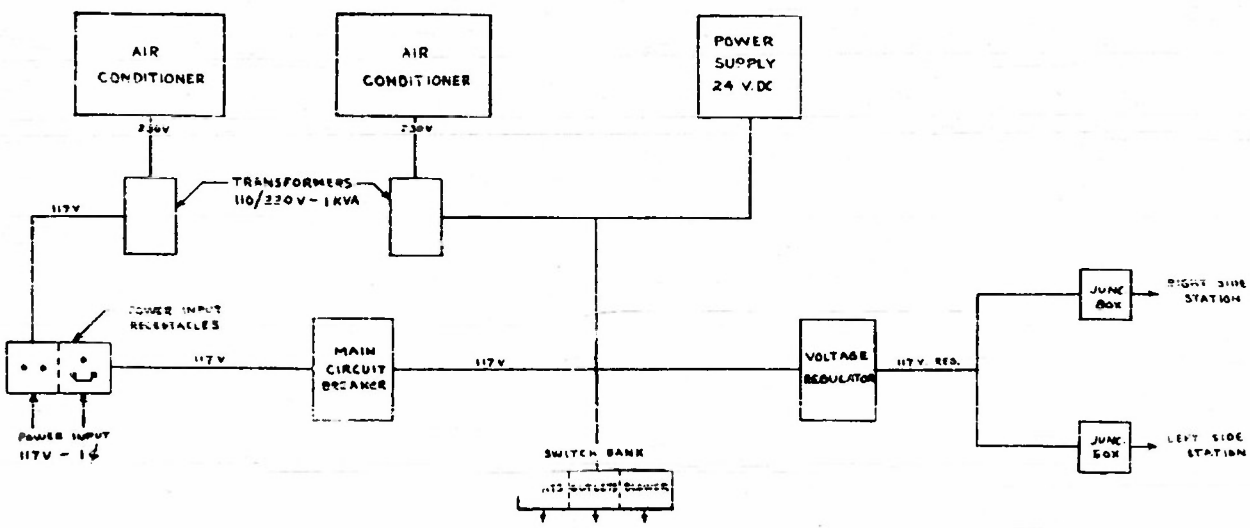


Figure 43 - Block Diagram, Power Distribution
Trailers 1, 2 and 3

	ANTENNA LOCATION	ANTENNA NUMBER	COAX PAIR NO.	RECEIVER NUMBER	CHANNEL COVERAGE
1.	Trailer No. 1 (R)	1	1	1-4	1-4
2.	Trailer No. 1 (L)	2	2	5-8	5-8
3.	Trailer No. 2 (R)	3	3	9-12	9-12
4.	Trailer No. 2 (L)	4	4	13-16	13-16
5.	Trailer No. 3 (R)	5	5	17-20	17-20
6.	Trailer No. 3 (L)	3	3	21-22	1-20

It is to be noted that the antenna listed under item 6 bears an antenna number of 3. This is due to the fact that this antenna feeds the standby station in trailer No. 3 which is equipped with tuneable receivers, 21 and 22. Therefore, this antenna is designed to the center frequency of twenty allocated channels which thus makes it identical to antenna No. 3. Although it does not operate at maximum efficiency through out the twenty channel band, it does operate satisfactorily.

2.1.2 Antenna Installation Procedure

The proper antenna is selected and mounted on the antenna mast while the antenna is in the folded down position. The gear box at the top of the antenna has two arms with clamps to which the antenna is attached. The azimuth position of the antenna is fixed by the position of the antenna mount however, the antenna is adjustable in elevation. The antenna should be clamped into position such that the mounting arms when in the full down position the antenna will be in the lowest angle which is desired to be scanned.

The proper coax pair is connected to the antenna and the leads clamped to the antenna mast near the top with sufficient slack to allow full movement of the antenna in azimuth and elevation. The leads are then fed thru the opening on the side of the trailer and connected to the antenna coupler.

The antenna mast may now be raised to the "UP" position and secured in position and the system is ready for operation.

2.2 Antenna Position Control Installation

The antenna position control system requires no preparation for operation as all equipment is permanently installed and requires only a system check which is explained in the section on operation of this system.

3.0 Inter and Intra Trailer Wiring

3.1 Inter-trailer Wiring

The inter-trailer cables are connected between trailers whereupon the inter-com and three timing circuits are ready for inter-trailer operation.

3.2 Intra-trailer Wiring

The only two circuits within the trailer junction box which are not complete are the ZERO and RANGE TIME signals and to make them complete requires that their signal source be connected to the system.

The ZERO TIME signal is generated by a photo-electric cell unit which must be mounted exposed to ground zero so that at the time of the flash and pulse signal will be generated and fed through a pair of leads to a trailer junction box and hence fed to the inter-trailer system. It is necessary to have only one photo-electric unit as its signal will be fed to all ground stations through the inter-trailer wiring system.

The RANGE TIME signal (if used) originating external to the telemetering is connected to the proper terminals in the junction box of one of the trailers and hence is fed to the system.

SECTION III

OPERATION

1.0 T/M Trailer Power System

1.1 Supplying Power to Trailer

1.1.1 Check power cable connections and position of line circuit breakers (OFF) and also make check of fuel and oil levels of power unit engine.

1.1.2 Energize engine-generator power unit as per posted instructions and allow a warm-up period.

1.1.3 Adjust voltage and frequency output of power unit as per posted instructions.

1.1.4 Turn "ON" power unit output circuit breaker and power is now supplied to the trailer.

1.2 Supplying Power to Trailer Components

1.2.1 Turn "ON" main circuit breaker.

1.2.2 LIGHTS - Turn "ON" lights switch on switch bank.

1.2.3 EXHAUST FAN - Turn - "ON" blower switch on switch bank.

1.2.4 OUTLET STRIP - Turn "ON" outlets switch on switch bank.

1.2.5 TELEMETERING STATIONS - Turn "ON" circuit breaker on Stabiline voltage regulator.

1.2.6 AIR-CONDITIONERS - Turn "ON" air conditioner circuit breakers.

1.2.7 ANTENNA CONTROL SYSTEM - Turn "ON" switch on 28 volt power supply.

1.3 Supplying Power to Auxiliary Air-Conditioner

1.3.1 Check power cable connections and position of line circuit breakers (OFF) and also make check of fuel and oil levels of power unit engine.

1.3.2 Energize engine-generator power unit as per posted instructions and allow a warm-up period.

1.3.3 Adjust voltage and frequency output of power unit as per posted instructions.

4. Turn "ON" power unit output circuit breaker and power is now supplied to auxiliary air-conditioner units.

2.0 Trailer Antenna System

2.1 Receiving Antenna System - See Figure 44

The two arrays of the receiving antenna are spaced a half-wavelength apart and the coax leads from the antenna to the antenna coupler differ in length by a quarter-wavelength. This combination gives a fairly broad antenna radiation pattern since it is necessary to simultaneously receive as many as four signals from airborne telemetering units on a single antenna.

The antenna coupler (See Figure 45 and 46) used to affords the use of four receivers feeding from a single antenna array. Actually the antenna is comprised of two antenna arrays, each having a coax lead to the coupler. The coupler consists of three balanced bridge circuits and when employed in multiple receiver installations such as this, the coupler affords excellent isolation between receivers, thereby reducing the spurious signals caused by local oscillator inter-action and the pulling in effect between receivers connected to a common antenna system and tuned to adjacent frequencies. The insertion loss inherent in this type of unit is more than compensated for by antenna gain.

2.2 Antenna Position - Control System - See Figure 47

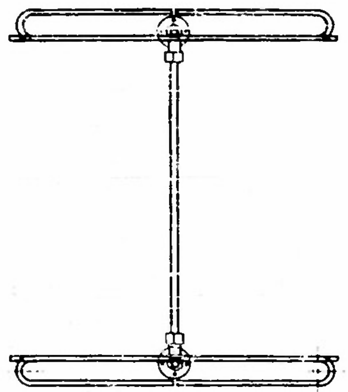
Operation of the antenna control system is from the ANTENNA POSITION CONTROL PANEL. After the antenna has been properly mounted the 28 volt power supply is energized, the elevation and azimuth indicated positions on the position indicator is corrected by means of the elevation and azimuth CALIBRATION ADJUST so that the indicator will indicate the antenna's true position in relation to the trailer.

Antenna movement can be effected by actuating the proper switch on the ANTENNA POSITION CONTROL PANEL for either azimuth or elevation movement. Prior to an actual operation, the antenna is positioned in the anticipated direction of radiated signals and then during the operation the antenna position is adjusted for maximum signal strength indication on the receivers. However, since four receivers are operated on one antenna array it may not be possible to peak the signal strength indication on all four receivers therefore, it will be necessary to compromise on the levels.

3.0 Inter and Intra - Trailer Wiring - See Figure 48

3.1 Inter-trailer Wiring

The inter-trailer cables parallels the inter-com, zero time, range time, and 1 cps time circuits in the three trailers so that communications, synchronizing and timing is possible between all the trailers.



ITEM #	Y-15477-1 NO. REQ	Y-15477-2 NO. REQ	Y-15477-3 NO. REQ	Y-15477-4 NO. REQ	Y-15477-5 NO. REQ	PART NO.	DESCRIPTION
1	2	--	–	–	--	Y-18051-1	ASS'Y.- ANT. ELEMENTS & SUPPORT
1	–	2	–	–	--	Y-18051-2	" " " "
1	–	–	2		--	Y-18051-3	" " " "
1	–	–	–	2	--	Y-18051-4	" " " "
1	—	—	–	–	2	Y-18051-5	" " " "
2	1	–	–	--	--	Y-12963-1	ANT. CROSSBAR SUPPORT
2	–	1	—	—	--	Y-12963-2	" " "
2	—	—	1	—	--	Y-12963-3	" " "
2	—	—	--	1	—	Y-12963-4	" " "
2	—	—	--	—	1	Y-12963-5	" " "
3	2	2	2	2	2	Y-18030	ASS'Y. CO-AX TERMINATION
4	2	2	2	2	2	AN-824-10D	TEE

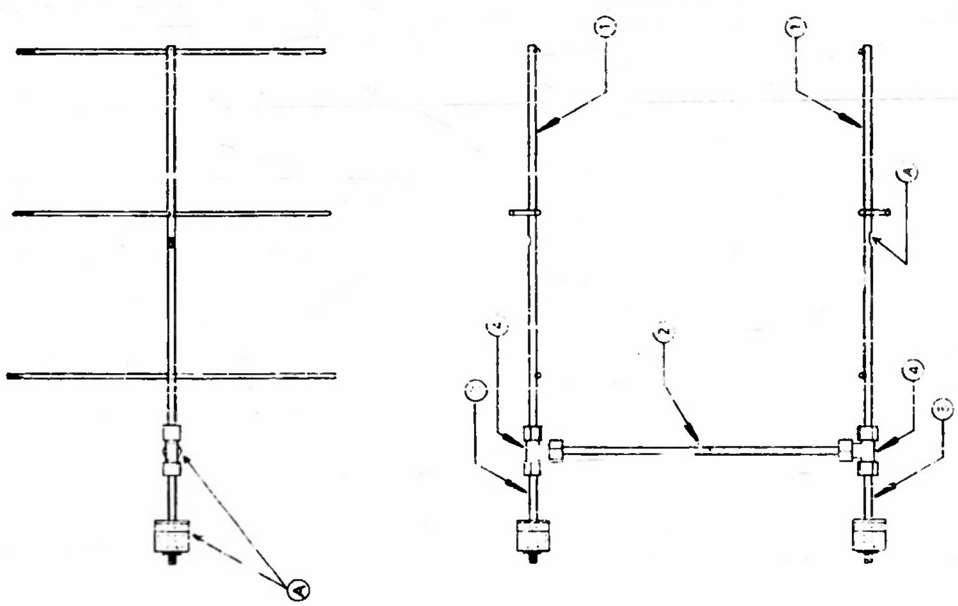


Figure 44 - Trailer Receiving Antenna Assembly

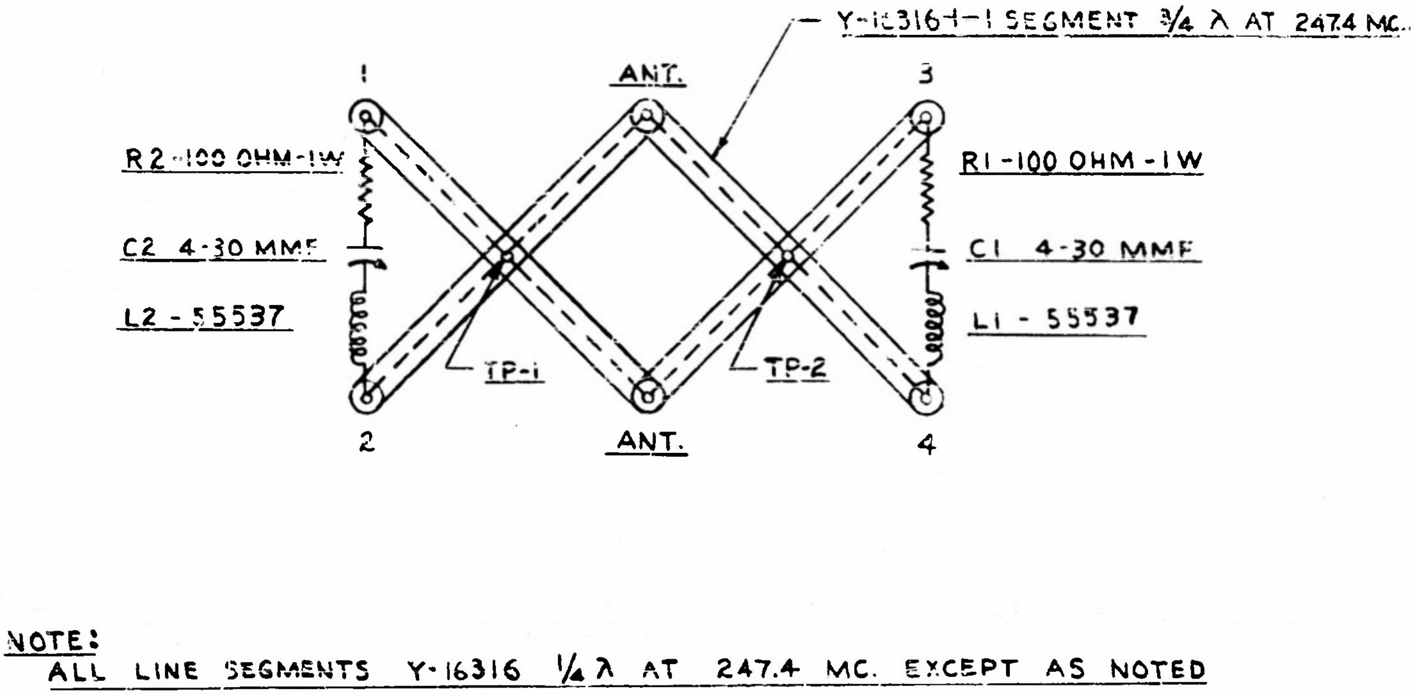


Figure 45 - Schematic, Antenna Coupler

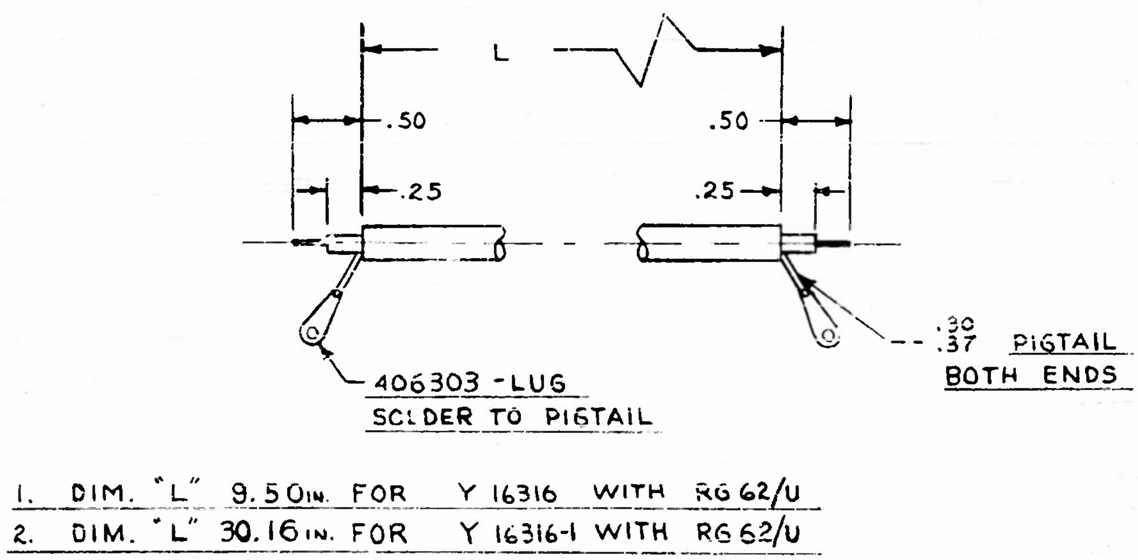


Figure 46 - Segments, Antenna Coupler

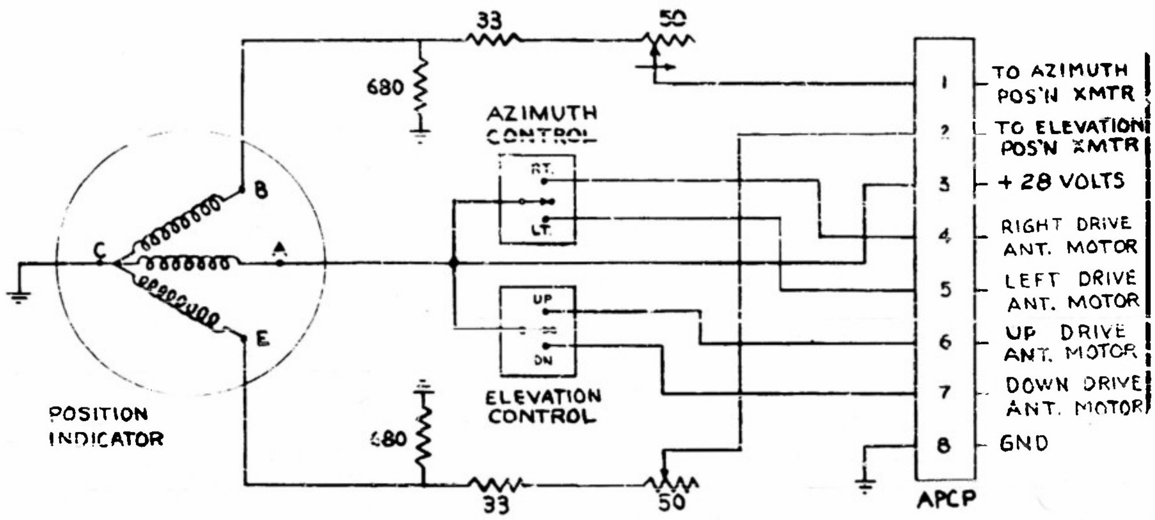


Figure 47 - Schematic, Antenna Position Control Panel

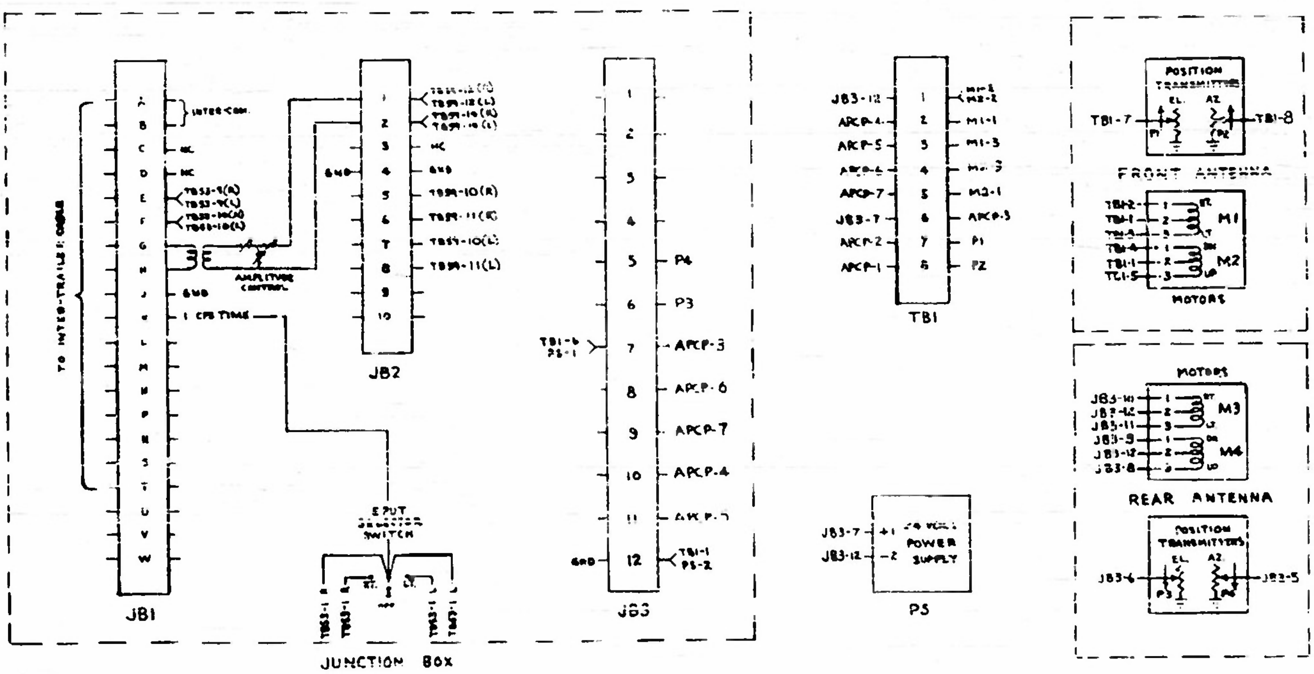


Figure 48 - Wiring Diagram, Intra Trailer

3.2 Intra-Trailer Wiring

3.2.1 Inter-communications

Within each trailer, there are two field phones and an amplifier. By turning the amplifier on, it is possible to monitor the inter-com without using the field phones.

3.2.2 Time Base

Basically the timing used, is the TIME BASE which is a 1 cps pulse taken off from the EPUT meter in each station. In each trailer there is mounted on the junction box, an EPUT SELECTOR SWITCH. Each of the two EPUTS in each trailer feeds a 1 cps timing signal to this switch such that it is possible to select one signal but not both, and feed this signal to the two oscillograph control panels and hence to all recorders. However, its desirable to have the same timing signals on all the recorders of the three trailers therefore, all trailers have their time base circuits in parallel. Since it is possible to have three time base signals simultaneously on the system, during an actual operation only one trailer will have their switch in the "ON" position and the other two will be in the "OFF" position. In case of a failure in the trailer, one of the other trailers will turn their switch to the "ON" position and a time base signal will continue to be fed to the system.

3.2.3 Range Time

The RANGE TIME SIGNAL is fed thru an isolation transformer and an amplitude control in the trailer junction box and then goes directly to the oscillograph, sync. plug via the station control cabinet.

SECTION IV

MAINTENANCE

1.0 Electrical Power System

1.1 Engine - Generator Power Units

Proper maintenance of the engine-generator power units is a prime prerequisite for satisfactory and dependable operation of the units and hence the telemetering stations since a power failure at a critical time would decommission the entire telemetering trailer.

A War Department technical manual, TM 11-904, is included in the catalog file of each trailer for the PE-95K power units.

1.2 Air-Conditioner Units

A manufacturer's operational and maintenance manual, is included in the catalog file of each trailer for the PE-95K power units.

1.3 Voltage Regulator

The regulator is fitt[illegible] with a quick-trip magnetic circuit breaker, which serves as an "ON-OFF" switch for the control circuit as well as the power circuit. Figure 49 shows a schematic of the regulator.

By closing the circuit breaker "ON-OFF" switch the control circuit will be energized and the pilot light will light, indicating that the control circuit is receiving power. In 15 or 20 seconds either the raise or lower thyratron tube will conduct causing the regulator to operate if correction is required.

1.3.1 Sensitivity Control

The setting of the control on the right front panel marked "Sensitivity" controls the sensitivity of the regulator. The term "Sensitivity" defines the value of voltage departure from the nominal output which will cause the regulator to correct. Increasing the setting of the sensitivity control causes the regulator to correct for smaller voltage variations. This control may be adjusted with a coin or a screw driver after removing the dress cap which is screwed over the control. Figure 50 is a schematic of the control circuit.

In starting the regulator the setting of the control should be increased to a point at which the regulator continuously "hunts" (i.e., motor does not cease operating). The control should then be "backed-off" a small amount causing the regulator to stop hunting. Experience in each application will best determine the amount to be "backed-off."

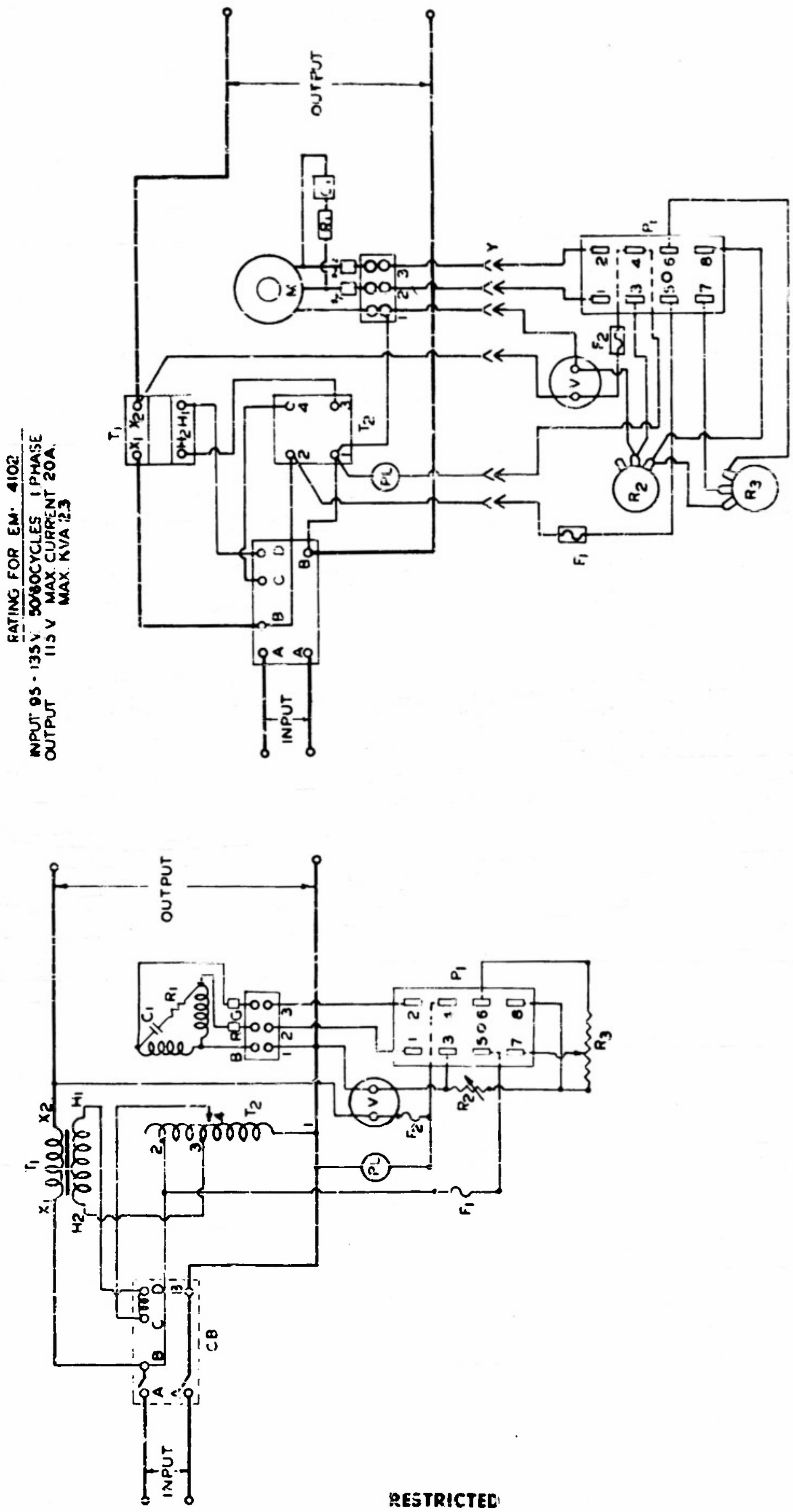


Figure 49 - Schematic and Wiring Stabiline Voltage Regulator

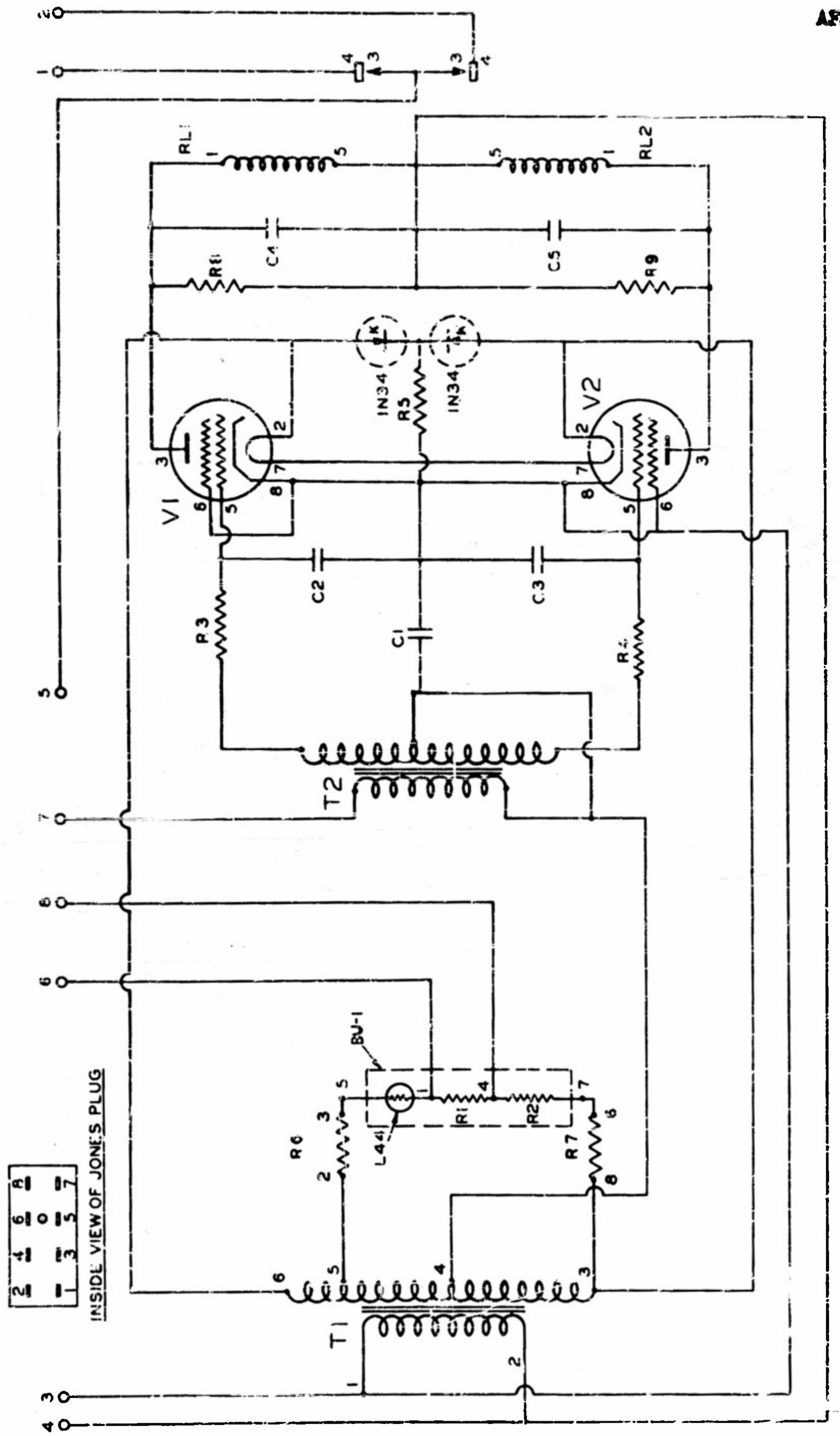


Figure 50 - Schematic and Wiring Control Circuit Voltage Regulator

1.3.2 Range Control

The setting of the control on the left front panel marked "Output Voltage" determines the nominal output voltage of the regulator. It is covered as mentioned above under "Sensitivity Control". In setting the output voltage reference should be made to the voltmeter indication. The range control should be set so that the desired output voltage is indicated on the meter.

1.3.3 Maintenance

Routine maintenance will consist of replacing the thyratron type 2050 tubes, the BU-1 voltage sensitive element, and the small relays. These are all plug-in components.

1.3.4 If the regulator appears to be inoperative or operating improperly, the following steps should be taken in the order given:

1.3.4.1 Check fuses.

1.3.4.1.1 Incoming line.

1.3.4.1.2 Brush lead fuse or fuses if used (see Figure 49)

1.3.4.1.3 Control circuit type 3AG, 3 amps., (see wiring diagram as above. If pilot light is "ON" this fuse is good).

1.3.4.1.4 Motor circuit type 3AG, 3 amps., (see wiring diagram as above.)

1.3.4.2 Check incoming line and compare with nameplate data.

1.3.4.2.1 Voltage

1.3.4.2.2 Frequency

1.3.4.2.3 Number of phases.

1.3.4.3 Replace type 2050 tubes in control circuit.

1.3.4.4 Replace BU-1 in control circuit.

1.3.4.5 Replace relays in control circuit.

1.3.4.6 If trouble still persists, remove the control circuit. This is accomplished by unscrewing the "hold-in" screws located near the top and bottom of the chassis. The control circuit may be removed by pulling it out of its mounting socket.

1.3.4.6.1 Set the control circuit aside.

1.3.4.6.2 Locate the motor terminal board mounted on the motor mounting plate and remove the three motor connections after noting their positions so that replacement may be made.

1.3.4.6.3 Apply 115 volts from an external source to the black and green leads and then to the black and red leads of the motor.

1.3.4.6.4 It should be possible to cause the motor to turn the POWERSTAT shaft through its complete range. This will change the output voltage of the regulator as indicated by the panel voltmeter. It should be possible to manually select the proper position to give the desired output voltage indicating that the motor and power circuit are in proper operating condition. If this is found to be true it will be desirable to obtain an exchange control circuit. These exchange units are available for immediate shipment from the manufacturer.

1.3.4.7 In case the tests performed under item 1.3.4.6 show that there is trouble in the motor or power circuit, it can usually be found quite easily if reference is made to Figure 49.

2.0 Antenna System

2.1 Antenna Mast

The motorized masts require periodic inspection and lubrication especially after adverse weather conditions.

2.2 Receiving Antenna Assembly

All connections should be periodically inspected and cleaned to prevent corrosion.

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